Gas Journal

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Editorial Notes

Flexibility in the Gas Industry

On several occasions we have urged that the Gas Industry should regard itself as a great chemical industry preparing finished products and raw materials of immense national importance by the scientific treatment of raw coal. It has for long seemed to us that it insufficiently emphasizes the magnitude of its operations and services, and insufficiently realizes its potentialities over a remarkably wide field. The Gas Industry enjoys the inestimable asset of flexibility in its processes, a flexibility which makes it possible largely to balance the markets of its by-products so as to enable the supply of gas at a low price irrespective of the demand for these products. On the other hand, it is only comparatively recently that efforts have been put forward within the Industry to stimulate the demand for these products and so to prepare and market them as to satisfy modern needs and likely future requirements. The major aim of the Gas Industry is, of course, to supply gaseous energy at the lowest possible cost. The Industry is protected by statute in the supply of gas; in the areas scheduled for supply no one else can come along and compete in gas supply. There is no such protection in regard to the supply of other products which go hand in hand with the present practice of carbonization at gas-works. Anybody can compete with coke, for example, in a free market; and it is argued that the Industry would be in a more secure position if it could supply cheap gas without in any way being influenced by market fluctuations of by-products. This argument is advanced by advocates of complete gasification, and it is sound enough. All developments should be watched, investigated, and encouraged which might make possible the production of gas at a very cheap rate by complete gasification. One process which appears of promise is at the moment being investigated by The Institution of Gas Engineers, and we look forward to the presentation of the results of this work at the Autumn Research Meeting of the Institution in a couple of months' time. It is the process which employs oxygen in the continuous gasification of coal under pressure, and it is stated that gas of a calorific value of 500 B.Th.U. per cu.ft. can be made without difficulty and that the cost of oxygen made by a simplified Linde process is much lower than hitherto. That pressure systems have opened up new fields for exploration goes without saying, and we may yet find complete gasification of coal the most economical means of making gas.

William Young Memorial Lecture

This has yet to be proved, however, whereas in the meantime it is a proved fact that the better the market for coke and other by-products the lower the price of gas, and that a means of extending the sale of gas is to make coke of good quality; and we see no reason why, if there is a public demand for more than one type of solid smokeless fuel, which we know there is, and the Gas Industry finds that it can make an adequate profit on its manufacture, the Industry should not set about its production. This question of flexibility and balance in the Gas Industry was the theme of the William Young Memorial Lecture which Dr. J. G. King, Chief Chemist at the Fuel Research Station, delivered last Thursday at the Meeting in Edinburgh of the North British Association of Gas Managers. Research in any industry must have a definite practical object, and Dr. King shares our view that in the Gas Industry this object should be mainly the increase of flexibility by the development of new outlets for the products of the Industry. "It is," he says, "only by the production of diverse products suitable for many markets that true flexibility can be achieved—that is, one which will allow of internal changes to suit the variations of markets so that plants can be maintained at full production despite seasonal or other variations and the gradual changes which occur from year to year." Dr. King's Lecture is a study of the modern developments in terms of the main products of the Industry, gas, coke, and tar, indicating how these can be modified in properties so that the manufacture of any one need not be

limited, as it is now, by the avoidance of over-production of any of the others.

The Lecture covers a very broad canvas, and throughout there are glimpses of the possibilities of the application of research to large scale practice. In one section of the Lecture Dr. King discusses total gasification by the pressure process due to Lurgi to which we have referred. In Germany this operates on brown coal, which is a particularly reactive fuel, and it remains to be established whether British coals are suitable for the process, and, of course, its operation in Great Britain will depend on the possibility of supplying oxygen at a sufficiently low price. But, states Dr. King—and research is jointly being carried out by the Institution and the Fuel Research Station —" high pressure gasification with cheap oxygen has the greatest potentialities for future development." Dr. King also refers to the production of liquid fuels from carbon monoxide and hydrogen by the Fischer-Tropsch process. Plant operating on this process has been installed on a large scale in Germany, and it is reported that at the end of this year production of liquid products will be at the rate of 500,000 tons per annum.

Research at East Greenwich

An experimental plant is in use at the Fuel Research Station, and the products consist of 8% of condensable hydrocarbons (propane, butane, &c.) which is available for condensation in cylinders, 50% of motor spirit, 39% of diesel oil, and 3% of paraffin wax. The diesel oil is valuable as a blending stock, and it has been shown that a 50:50 mixture with creosote is suitable for the high-speed diesel engine, so that, were this diesel oil available in the Gas Industry, it would render an equal amount of creosote saleable in this profitable market. " The process as a whole," states Dr. King, " does commend itself to the Gas Industry. Also, despite the economic limit at present assessed for commercial plant it would seem that unit converters of 35,300 cu.ft. per day capacity would be worthy of trial at different points. Four such units would require 20,000 tons of coke per annum and 360 million cu.ft. of coal gas and would produce 4,000 tons of liquid products per annum. Such quantities are within the reach of many of the bigger gas undertakings of this country. Alternatively it should be possible by centralizing the plant to provide from a number of towns the coke necessary for a plant of the larger size."

Again, the interests of flexibility in the Gas Industry could well be served under certain conditions if coal could replace the coke normally used in water gas manufacture. These conditions are, of course, those in which the coke market is more favourable than that for gas. Experiments have been carried out at the Fuel Research Station on this problem in which South Wales coals of low volatile matter have been successfully used at a thermal efficiency of gas production comparable to that with coke. At present the marked reduction in output is a difficulty, but Dr. King suggests that it is almost certain that further experience will remove this difficulty, and it may be accepted that the replacement of coke by low volatile coals, at a time when the coke market is active, is a definite contribution towards the increase of flexibility in the Gas Industry. Then Dr. King discusses the preparation of cokes suitable for the ordinary firegrate, the carbonization of cannel, the production of active carbon, and the manufacture of reactive coke for motor lorry producers—an application discussed in these columns last week. It seems more than possible that an impetus could be given to the design and supply of producer-gas driven vehicles if the Gas Industry were able to supply at many points throughout the country suitable graded fuels.

Dr. King's Lecture, which is published in our issue today, shows that, were gas the sole product of the Industry, as in the case of complete gasification, a measure of flexibility could be attained by extending the utilization of gas through, for example, compressed gas or hydrocarbon synthesis. It would seem more promising, however, concludes Dr. King, that the Gas Industry should become a " solid fuel " industry to a greater extent and, by varying the proportion of many products to the immediate demand, so balance its production as to achieve better results as regards maintenance of output at all seasons. This, we feel, is a right aim, but Dr. King does not mention the question of overhaul of plant, which is effected during periods of low demand and to this extent offsets the fact that plant is temporarily out of action. The seasonal variation of load is not entirely the unmixed evil the Lecture might imply.

A Challenge

The magnificent display of public lighting by gas at Folkestone, staged in connection with the Annual Conference of the Association of Public Lighting Engineers, has caused no small stir in electrical circles. The *Electrical Review*, for example, suggests that " a tremendous effort must have been made by the Gas Industry to produce such excellent results," and expresses the hope that electrical men " will not be tempted to sit on the fence of content." Our Industry has made a great effort, and is determined that its efforts shall be continued in developing gas lighting equipment. The improvement in the performance of the wide range of street lighting fittings now available has been well demonstrated at Folkestone. It has given no satisfaction to those in the electrical camp, but it must have given renewed confidence and inspiration to the gas delegates who attended the Conference and have convinced anyone responsible for local administration that gas is the very reverse of a back number for the adequate illumination of our highways under modern and most exacting conditions.

We commented last week on the new low-pressure lamp developed by Mr. George Keith, which shows an increased light output of a matter of 50% for the same amount of gas consumed. This type of advance is all very perturbing to the electrical interests. In the course of the joint discussion on the Paper by Mr. George Keith describing his new lamp, and on that by Mr. Dean Chandler dealing with high-pressure gas street lighting, Mr. W. J. Jones, of the Lighting Service Bureau of the Electric Lamp Manufacturers' Association, with wish father to the thought, said he was not at all afraid or worried as to the effect which this new low-pressure lamp was likely to have, and he then went on to attack the Gas Industry's figures in regard to the performance of high-pressure lamps. Being so unafraid of competition from gas, he took the trouble to submit high-pressure lanterns to the National Physical Laboratory for test. Unwisely using the platform of the Association of Public Lighting Engineers to launch his attack on gas—and it was a move the reverse of popular—he suggested that figures resulting from tests by the N.P.L. would " complete this important session on high-pressure gas." The figures quoted by Mr. Jones were just about two-thirds of those which the Gas Industry has been obtaining for ten years, and their accuracy was naturally refuted at the Conference.

Mr. Jones quoted 216 lumens per cu.ft. of gas for high-

pressure gas, but more than that is being obtained with low pressure. The figure of 350 lumens per cu.ft. given in the Papers at the Conference represents the efficiency of the lamp taking into account all absorption by glassware and reflectors. It was pointed out that the research laboratories of the Gas Light and Coke Company and the South Metropolitan Gas Company have for many years been concerned with the photometry of high and low pressure gas units and that the results obtained have been confirmed in practice. Mr. Dean Chandler mentioned that just prior to the Conference a test on a Supervia lamp had shown a luminous output of 370 lumens per cu.ft. for lamp and refractor and 380 lumens excluding the refractor. Mr. C. A. Masterman emphasized the great amount of care and trouble taken in the research laboratories in the Gas Industry to obtain reliable results such as those quoted at the Conference, and he reminded the meeting that the figures which had been challenged had been used for a long period of years to design street lighting installations which were guaranteed to give a stated illumination. The Gas Light and Coke Company and other gas undertakings, working on these figures, were under penalty if the specification was not maintained.

At the Conference an invitation was publicly issued to Mr. Jones to visit the Watson House Laboratories of the Gas Light and Coke Company and measure for himself the performance of the lamps to which reference had been made; and the President, deprecating the use of the A.P.L.E. platform by Mr. Jones to disparage a rival illuminant, suggested that, if Mr. Jones accepted the invitation, then the results of the tests should be published. Faced with the invitation, Mr. Jones neither accepted nor refused it. If, however, he does not accept the challenge he will cut a very sorry figure indeed, unafraid of competition as he asserts himself to be.

New Plant at Copenhagen

In our news columns last week we recorded the official inauguration by the Lord Mayor of Manchester, Alderman J. Toole, of new and extensive gas making and treating plant at the Eastern Works of the Copenhagen Lighting Department. The occasion marked the successful culmination of an ambitious scheme of reconstruction embarked upon in 1933, and the citizens of Copenhagen may well feel proud of a very fine gas-works modern in every respect. It was a singularly happy coincidence that the handing-over of the new plant to the Department should occur at the time of the official visit of Alderman Toole to Copenhagen. He has been an enthusiastic member of the Manchester Gas Committee for 20 years, and through personal knowledge he was able to testify in the most generous terms to the repute of the great Manchester firm who have been responsible for the carbonizing plant.

The occasion was a great day for the Lighting Department and the citizens of Copenhagen; it also constituted a well-earned tribute to British engineering in the Gas Industry. Not only the carbonizing bench but much of the auxiliary plant have been manufactured and installed by leading firms in the British Gas Industry; and the liveliest satisfaction with the plant's working was expressed by Mr. J. E. Börresen, Director of the Gas and Electricity Works, in accepting the new installation. The extensions are described in an illustrated account on later pages of our issue to-day. The main contractors were Messrs. West's Gas Improvement Company, and in handing-over the plant Sir Frederick West was able to refer to the fact that it is 42 years since his firm carried out their first contract with the Copenhagen Lighting Department. The carbonizing system adopted is the West-vertical, the capacity being 5½ million cu.ft. of gas per day. The primary reason for this choice was the suitability of the coke produced for the existing central heating systems in Denmark and the domestic stoves commonly used in the Danish household; and the plant is fulfilling all requirements in this respect, at the same time yielding, from a mixture of Durham coals, in the neighbourhood of 82 therms of 510 B.Th.U. gas per ton of coal carbonized. Working details are included in our description of the new plant, from which it will be noted that benzole recovery and gas drying are practised.

Our account, too, gives some idea of the organization of the Copenhagen Gas Department generally and shows clearly how confidently the Department is pursuing a far-sighted policy. With the new plant its consumers are assured of a first-rate heat service; and the new tariffs for gas, both domestic and industrial, which the Department intends to put into operation during this autumn will doubtless make steeper the rise in the curve of progress depicted on a later page. From this curve it can be seen that over the past ten years there has been an increase of over 34% in the quantity of gas manufactured. Of the total sales, 75% is used for domestic purposes at a price equivalent to 9d. per therm. When it is considered that gas can make little headway for heating, closed coke stoves being the established custom, that the gas is made from imported raw material, that the incidence of the load is abnormal in that the amount of gas demanded on Christmas Eve each year is more than 40% greater than the volume supplied on the maximum day for the rest of the year, and that the Gas Department contributes yearly to the finances of the Municipality an amount equivalent to over £100,000, it will be agreed that this is a highly creditable achievement. Moreover, the new tariffs will mean a reduction in gas prices and will, we have no doubt, result in a jump in gas sales during the coming year.

Nor does the Copenhagen Lighting Department rely on low price only to effect gas sales. It is organized to give a service as distinct from selling a commodity. Service includes the staging of lectures and demonstrations by experts, and a trained staff undertakes home-service calls, while there is a special demonstration workshop for dealing with the industrial side of the business. An interesting feature of the distribution work is that all installation work beyond the meter is carried out by approved private gasfitters, who under the supervision of the Department carcass premises and fit all gas appliances in conformity with the Department's regulations. Altogether it will be gathered that the Lighting Department is very much alive on both the manufacturing and the distribution and sales sides. The up-to-date methods employed in all phases of its work are certain to ensure the prosperity of gas and to widen its field of service in Copenhagen.

Benzole in New Zealand

It has been decided by the Government of New Zealand to exempt from excise duty benzole recovered as a by-product in the manufacture of town gas. In making the announcement the Minister of Mines stated that exemption will be limited to a total quantity of 500,000 gallons a year, subject to the condition that substantially all New Zealand coal is used in its production. At present benzole is being recovered principally by the

Christchurch Gas, Coal, and Coke Company, Ltd., and reference was made to the high quality of the product by the Minister of Mines in announcing the decision, which should act as an impetus to other gas undertakings in New Zealand to enter the market. We know that Mr. F. W. J. Belton, Engineer to the Company, has for many years endeavoured to persuade successive New Zealand Governments to grant this concession on home produced motor spirit, and doubtless the success of his practice at Christchurch has largely influenced the Cabinet in their decision. Once again the national importance of the Gas Industry has been demonstrated; if the gas undertakings in New Zealand installed plant for the recovery of benzole this would represent a demand for an additional 12,000 to 14,000 tons of coal per annum. Though tardy, the New Zealand Government's recognition of the part which the Gas Industry can play in the national economy is welcome.

Stockholders' Interest

THE assertion that stockholders do not take enough interest in the companies in which their money is invested points, if it is correct, to an unfortunate state of affairs; and it was made in all seriousness a few days ago by the chairman of an outstandingly prosperous industrial concern whose speciality is in ever-increasing demand. Indeed, he himself admitted that he had felt impelled to " rather slate " his stockholders on this account. It has been remarked on numberless occasions by company chairmen, as an explanation of small attendances at meetings, that, when matters are proceeding satisfactorily, shareholders will not put themselves to the trouble of being present. If one could safely assume that failure to be present at a meeting was the outward proof of a mental state of complete satisfaction, things would not be so bad; but there is clearly an alternative—indifference—on behalf of which, from the point of view of the undertaking in which the money is invested, there is nothing good to be urged.

An indifferent shareholder can be regarded only as a missed opportunity, like an indifferent customer, but " more so." And just as indifference may not be altogether the fault of the customer, so, it may be submitted, lack of interest in the affairs of the companies in which they have invested their money may not be attributable solely to the shareholders. Salesmen are trained, and trained again—or they should be trained, and trained again—in the vital art of creating interest on the part of their public in the commodities of which they are desirous of disposing. And who shall say that there is not need for the exercise of the same gentle art—though not, perhaps, to the same extent—by company chairmen?

At any rate, the effort is well worth the making, even though the results may fall somewhat short of the most sanguine expectations. It is true that the gentleman to whose remark on the subject reference has already been made declared that it had been his policy " to endeavour, not only at the meetings, but at all times, to encourage the personal interest of the stockholders in the company," but, " except in one or two isolated cases," he had " never got a single letter from a stockholder giving a word of praise or a line of encouragement." One effort in particular had taught him a lesson—it had taught him " never to write to a stockholder unless he enclosed a dividend, because that seemed to be his sole interest." It seems to us that he should steadily persevere in his efforts to create in his stockholders more interest in the affairs of their company, and that other chairmen in the same position of controlling commodities the distribution of which is of direct benefit to the community should do likewise.

Naturally, in this connection, there comes to mind our own Industry, which possesses unlimited scope for contributing to the greater welfare of the public, if only that public can be made, and kept, " gas-minded." What better avenue of approach can be conceived than through the gas shareholder, if care be taken that his mind is not focussed solely on his dividend? In urging the exercise of the liveliest efforts to create, and then to increase, this interest on the part of gas shareholders in the affairs of the undertakings in which they have invested their money, we would hasten to make generous acknowledgment of the big strides that have been taken already in this direction. Search over such memories as remain of attendance at many hundreds of gas company meetings reveals an enormous improvement of late years in the average " chairman's address." In contrast with the " dry as dust " statistics provided by officials which too often constituted the " bill of fare " for the gas chairman of forty or more years ago—and, be it whispered, which were not invariably quoted accurately by him—we have to-day speeches from the chair which may be relied upon to contain points that should excite the interest of the thoughtful proprietor, and this is the policy which we desire to see exploited to the furthest possible extent. The all-importance of the " satisfied consumer " is frequently acclaimed; we would rank along with him, as deserving of cultivation, the " interested shareholder."

Personal

Mr. C. E. SMITH, Engineer, Manager, and Secretary of the Westhoughton Consumers' Gas Company, has been appointed Engineer and Manager of the Brigg Gas Department, and will take up his duties on Oct. 1.

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At the annual meeting of the Shrewsbury Gas Light Company on Sept. 8 it was announced by the Chairman, Alderman W. Adams, that Mr. C. S. ASBURY had been appointed to the Board to fill the vacancy occasioned by the death of Mr. Robert Williams.

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Mr. FRANK WALTON MIDDLETON, who holds the position of Commercial Manager of the Old Silkstone Chemical Works, Ltd., Dodworth, near Barnsley, has been appointed a Director of the Company.

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The Staff and employees of the County Borough of Stockport Gas Department have presented Mr. R. L. GREAVES (Assistant Engineer and Manager) with a handsome bookcase on his departure to take up his new appointment as Engineer and General Manager of the County Borough of St. Helens Gas Department.

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Mr. W. S. STREDWICK, late of Santos, has been appointed Assistant Engineer and Manager of the Bournemouth Gas and Water Company.

Obituary

We regret to announce the death at the age of 77 of Mr. ROBERT BARRETT, whose retirement from the position of Engineer and Manager of the Clitheroe Gas Department was recorded in our issue for March 24, 1937.

Mr. Barrett joined the Clitheroe Water Undertaking, of which his father was Manager, in 1880, but was transferred to the Gas Undertaking a year later, succeeding to the Managership at the age of 35. He was responsible for much re-construction at the Clitheroe Works, erecting one of the earlier waterless gasholders in this country in 1930.

British Commercial Gas Association

Programme for Annual Conference

The following skeleton programme has been issued in connection with the Annual Conference of the British Commercial Gas Association to be held in Manchester, under the Presidency of Councillor W. P. Jackson (Chairman of the Manchester Gas Committee), from Sept. 26 to 29 next.

Sunday, Sept. 26.

8 p.m. . . .	Banqueting Hall, Midland Hotel	Showing of new Gas Films for 1937-38 season. Ladies invited.

Monday, Sept. 27.

Alternative Excursions.

9.15 a.m. . .	From Albert Square .	(1) To the Lake District, returning to Albert Square, arriving 6.15 p.m. Ladies invited.
or 10.30 a.m. . .	From Albert Square .	(2) To Blackpool, returning to Albert Square, arriving 6.15 p.m. Ladies invited.
8.0 to 8.30 p.m.	The Town Hall . .	Reception of Conference Delegates and ladies by the Right Honourable the Lord Mayor of Manchester, Alderman J. Toole, J.P., followed by a Dance. Carriages at 11.0 p.m.

Tuesday, Sept. 28.

10.0 a.m. . .	The Town Hall . .	Opening Session of the Conference. Presidential Address by Councillor W. P. Jackson, J.P., President of the Association, Chairman of the City of Manchester Gas Committee. Address by Mr. Kenneth R. Lindsay, M.P., Parliamentary Secretary to the Board of Education. Discussion to be opened by Dr. R. Veitch Clark, Medical Officer of Health, City of Manchester. Twenty-Sixth Annual General Meeting. Presentation of Annual Report by Mr. A. W. Smith, Chairman of the Executive Committee. Presentation of Annual Accounts by Mr. W. J. Sandeman, J.P., Hon. Treasurer. Presentation of Report on Visit to America by Eileen Murphy.
12.45 p.m. for 1.0 p.m. . .	Midland Hotel . .	Official Luncheon for delegates and ladies.
2.45 p.m. . .	From Albert Square by 'buses	Visit to Wythenshawe. Ladies invited. Tea will be served. Address by Prof. Winifred C. Cullis, C.B.E., M.A., D.Sc.
7.30 p.m. for 7.45 p.m. .	The Town Hall . .	Dinner to the Conference Delegates by the Chairman and Members of the City of Manchester Gas Committee.

Wednesday, Sept. 29.

10.0 a.m. . .	The Town Hall, Council Chamber	Address by Col. W. M. Carr, O.B.E., T.D., on Planned Selling, followed by Discussion.
11.15 a.m. . .	The Town Hall, Lord Mayor's Parlour	Display of 1937-38 Films.
12.15 p.m. . .	The Town Hall Extension	Visit to the New Showrooms of the City of Manchester Gas Department. Ladies invited.
12.45 p.m. for 1.15 p.m. . .	Midland Hotel . .	Luncheon by the President and Members to the Retiring President and the Members of the City of Manchester Gas Committee.

Alternative Visits.

2.30 p.m. . .	From Albert Square by 'buses	(1) A trip on the Ship Canal by courtesy of the Chairman and Directors of the Manchester Ship Canal Company. 2.30 p.m. Leave Albert Square. 2.45 p.m. Arrive No. 8 Dock, Trafford Road, and embark on steamer. 3.45 p.m. Arrive at Barton. 4.15 p.m. Leave Barton, arriving Manchester not later than 5.0 p.m. Ladies invited.
or		
2.30 p.m. . .	From Albert Square by 'buses	(2) Visit to the Partington Gas-Works of the Manchester Corporation. Arriving at Manchester at 5.0 p.m. Ladies invited.

NOTES.

GOLF.—The Prestbury Golf Club Committee kindly invite Delegates and ladies to become Honorary Members during the period of the Conference. Reduced fees will be arranged. Open for Sunday play.

LADIES.—A Bureau will be opened in the Town Hall for the information and assistance of ladies during their stay in Manchester.

In This Week's "JOURNAL"

Gas Plant Extensions at Copenhagen.

The Copenhagen Lighting Department (Gas and Electricity Works) celebrated the extensions recently carried out at the Eastern Gas-Works by a formal inauguration on the afternoon of Saturday, Sept. 4. The extensions comprise an installation of "Westvertical" retorts (5½ million cu.ft. per diem capacity), additions to the condensing and exhausting plant, a Holmes benzole recovery and a "Dri-Gas" plant, a Kent shunt meter, together with other plant specified in the course of this article. A comprehensive article describes the Copenhagen Gas Undertaking in general and the extensions at the Eastern Gas-Works in particular, for which we are primarily indebted to Mr. Börresen, Director of the Lighting Department, at whose cordial invitation the "GAS JOURNAL" was represented at the inauguration celebrations by Mr. Clifford King.

See p. 662.

Gas and the Bakery Trade.

Once again the pre-eminence of gas for the bakery trade was forcefully demonstrated by a series of fine displays by the British Gas Federation, the Gas Light and Coke Company, and leading appliance manufacturers at the forty-first Bakers', Confectioners', and Allied Traders' Exhibition, held at the Royal Agricultural Hall, Islington, from Sept. 4 to 10.

See p. 665.

North British Association.

The 76th Annual General Meeting of the North British Association of Gas Managers was held in the Freemasons' Hall, George Street, Edinburgh, on Thursday and Friday of last week, Sept. 9 and 10, Mr. James Jamieson, President of the Association, in the chair.

See p. 667.

Association of Public Lighting Engineers.

The Annual Conference of the Association of Public Lighting Engineers was held at Folkestone from Sept. 6 to 9 under the Presidency of Mr. C. I. Winstone, Public Lighting Superintendent to the Gas Light and Coke Company. We dealt with the papers of interest to the Gas Industry last week, and to-day is included a report of the general business and social functions.

See p 689.

William Young Memorial Lecture.

The question of flexibility and balance in the Gas Industry was the theme of the William Young Memorial Lecture which Dr. J. G. King, Chief Chemist at the Fuel Research Station, gave at the Meeting of the North British Association of Gas Managers. Research in any industry must have a definite practical object, and Dr. King suggests that this object should be mainly the increase of flexibility by the development of new outlets for the products of the Industry. "It is," he says, "only by the production of diverse products suitable for many markets that true flexibility can be achieved—that is, one which will allow of internal changes to suit the variations of markets so that plants can be maintained at full production despite seasonal or other variations and the gradual changes which occur from year to year." Dr. King's Lecture is a study of the modern developments in terms of the main products of the Industry, gas, coke, and tar, indicating how these can be modified in properties so that the manufacture of any one need not be limited, as it is now, by the avoidance of over-production of any of the others.

See p. 670.

Thin Tar Carpets.

The South Metropolitan Gas Company has been engaged in experiments connected with the development of thin carpets containing tar as binder, these carpets constituting an important modern development in road treatment which is becoming increasingly popular. The first step in tackling the problem was to draw up a specification for thin carpets, based on work in the laboratory, before large-scale trials were attempted. How this was arrived at is described in a booklet, "The Preparation of Thin Tar Carpets," just issued by the Company, extracts from which are published this week. The publication, a model of its kind, discusses the physical properties of tar and road-stones, the commercial development of Metro Veneer carpets, and the results given by the carpets. The report explains that insufficient time has yet elapsed for definite conclusions to be drawn from the experiments, but it is felt that it has been established that satisfactory gravel aggregate carpets—and defects have been confined almost entirely to carpets in which gravel has been used—can withstand heavy traffic for three years without becoming seriously affected.

See p. 684.

News in Brief

CURRENT EVENTS IN THE GAS INDUSTRY

A Change of Calorific Value from 450 B.Th.U. to 500 B.Th.U. per cu.ft. on and after Dec. 10, 1937, is announced by the Newport (Mon.) Gas Company.

Consumers in Folkestone are offered, during September only, a modern gas fire in colour in exchange for their old fire for 15s., or, fixed to an existing point, for 17s. 6d.

A Record Monthly Output was reported at a recent meeting of the North Berwick Town Council, when it was stated that the quantity of gas consumed during August exceeded 4 million cu.ft.

A Reduction in the price of gas by 1d. per 1,000 cu.ft. has been recommended by the Renfrew Gas Committee. Among the reasons for the reduction is the greatly increased gas consumption.

Damage by Fire to the extent of £25,000 was caused at the works of the General Gas Appliances, Ltd., Corporation Street, Audenshaw, last week. The principal damage was done to the main store, the contents of which were irreparably spoiled.

Applications are Invited by the Newton Abbot and District Gas and Coke Company, Ltd., for the position of Engineer and Manager at a commencing salary of £500 per annum. Further particulars of the position will be found elsewhere in this issue.

A Re-Organization Scheme is proposed by the Birkenhead Corporation Gas Committee, which has been making a careful enquiry into the working of the Undertaking. This involves the present system of yard management and the appointment of a Works Manager.

The Fracture of a Cable at one of the generators at the Aberdeen Electricity Works early on Sept. 10 caused a breakdown in the City's supply of electricity for lighting and power. In 15 minutes the breakdown in certain areas was remedied, but in other parts of the City it was about an hour before normal conditions were resumed.

Among the Objects of a Special Order for which the Hampton Court Gas Company intend to apply to the Board of Trade under the Gas Undertakings Acts, 1920 to 1934, is to empower the Company to establish a special purposes fund and a renewal fund and to make provisions as to the contributions to, and the amounts of, such funds.

Three Hundred New Houses were equipped with gas service by the Shrewsbury Gas Light Company during the past year. Attention to this satisfactory feature was drawn by the Chairman, Alderman W. Adams, at the annual meeting of the Company on Sept. 8. The annual report, which was abstracted in our issue for Aug. 25, shows an increase in the amount of gas sold of 2¾ million cu.ft.

The Heating by Gas of the Farnborough Road Council Schools was the subject of a report which was considered recently by the Southport Education Committee. The Committee have resolved that the cubic contents of certain schools be obtained for the purpose of comparison regarding the cost of heating by different classes of fuel, and that the Chairman and Vice-Chairman be empowered to select the schools for comparison.

A Special General Meeting of the Fellows and Associates of the Institute of Chemistry is to be held in November to approve a draft of a petition for a Supplemental Charter which the Council of the Institute propose to present to His Majesty the King in Council. The main change proposed is the institution of a third category of members—namely, "Registered Members of the Institute." These registered members will be required to have complied with exactly the same conditions as to training that are stipulated for admission to the Associateship and to have obtained a University degree which is accepted as exempting from any examination by the Institute for admission to the Associateship. The proposed change owes its origin to a provision in the Pharmacy and Poisons Act, 1933.

The Entry of the Deal and Walmer Gas Company was awarded third prize in the Trades Advertising Class of the Deal Carnival.

An Exhibition of space heating appliances is being held by the Liverpool Gas Company in the industrial showroom at their premises in Grenville Street. The exhibition which will remain open until Oct. 2 comprises modern space heating appliances of practically every kind, including steam boilers, radiant heat panels, unit air heaters, central heating boilers, and examples of air conditioning and hot air plant.

Amalgamation and Grouping

Severn Valley and Caldicot.

An offer has been made by the Severn Valley Gas Corporation to acquire the whole of Caldicot and District Gas Light and Coke Company's issued Ordinary shares.

The Directors of the latter Company are prepared to accept the offer in respect of their own holdings and recommend shareholders to do the same. The offer is for the shares of the Company *cum* dividend for the year to June 30, and the terms are as follows: For every 100 Ordinary shares of £1 each of the Caldicot and District Gas Light and Coke Company, either £185 in cash or 165 Ordinary shares of £1 each of Severn Valley Gas Corporation credited as fully paid, together with £3 10s. in cash. The shares of the Corporation offered in exchange will rank for dividend from Oct. 1. Cash at the rate of £1 2s. for each £1 Ordinary share will be paid in respect of any shares of the Corporation, which would fail to be allotted in fractions.

Torquay and Paignton and Totnes and Bridgetown.

Among the objects of a Special Order for which the Torquay and Paignton Gas Company intend to apply to the Board of Trade under the Gas Undertakings Acts, 1920 to 1934, is to provide for the purchase of the undertaking of the Totnes and Bridgetown Gas Light and Coke Company, Ltd., and to extend the existing limits of supply of the Torquay and Paignton Company.

United Kingdom and Ellesmere Port.

The Ellesmere Port Council has approved a recommendation for the sale in principle of the Gas Undertaking as being in the best interests of ratepayers and consumers.

The terms embodied in a letter from the United Kingdom Gas Corporation, Ltd., offering £137,000 were regarded as a useful basis for further negotiations. Two other companies are concerned, but have not made an offer to the Council, and they are to be requested to submit their offers not later than Sept. 21, by which time the Law and Parliamentary Committee will continue negotiations and report to the next meeting of the Council on Sept. 27.

Severn Valley Gas Corporation

Increased Interim Dividend Announced

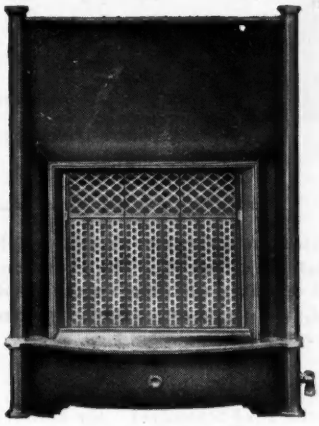
The Directors of the Severn Valley Gas Corporation, Ltd., announce a dividend at the rate of 4½% per annum, less income-tax, on the cumulative preference shares of the Corporation in respect of the half-year ended Sept. 30, 1937. This dividend is payable on Oct. 1, 1937, to holders of record Sept. 15, 1937.

An interim dividend at the rate of 2¾% actual, less income-tax, is also announced on the ordinary shares of the Corporation in respect of the year ended March 31, 1938, and is payable on Oct. 1, 1937, to holders of record Sept. 15, 1937. This 2¾% interim dividend on the ordinary shares compares with an interim dividend of 2½% last year when the final dividend was 2¾%, making a total distribution of 5¼% for the year.

High "Beam" Gas Fires

Richmonds' New Lists

The new gas fire lists of Richmonds Gas Stove Company, Ltd. (Radiation Ltd.), are now ready, providing as usual a real and valuable ally for the salesman. A prospective customer should not fail to find the design and colour shade required in these comprehensive publications. Beautifully printed in colours they contain illustrations and details of the full range of Richmonds High "Beam" designs, including several new features. The "Pillar" fire is introduced for the first time. This striking design embodies all the Radiation qualities, including self-lighting tap and full fire front. The fender it will be noted from our illustration extends to the full width of the fire frame—a feature lending distinction to this design. A minimum of ornamentation adds a modern "clean-cut" appearance, which is so much in vogue.



The "Pillar" Fire.

In addition to the size formerly listed, the "Georgian" fire is now also available 3 in. taller than hitherto. This additional size is the result of many requests made for a "Georgian" fire measuring 31 in. high. Gas fire finishes have been improved and their numbers increased. Three new colours have been added to Richmonds "Lustre" high grade finishes as follows: Blue (shaded silver), sea green (shaded silver), and red (shaded black). There are now ten attractive lustre shades available. The popularity of coloured paint finishes continues to grow, and the new additions to the Richmond range of colours are apple green (shaded dark green), red (shaded black), and chestnut brown (shaded gold), making a total of eight coloured paint finishes.

A useful feature of Richmonds 1937-38 showroom folder is the inclusion of a colour guide to all the above finishes—*i.e.*, eighteen colours, and this is a welcome additional sales help. Richmonds "Castile," "Flambeau," and "Cloister" High "Beam" fires are illustrated in natural colours in settings which suggest to the consumer just how well a gas fire can look when selected and fitted with care.

British Standards Institution

Specification for Sampling and Analysis of Coal and Coke for Test Trials

Further steps in the direction of setting up nationally agreed standard methods of sampling and analysis of coal and coke have been taken by the British Standards Institution with the issue of B.S.S. 735-1937, dealing with Methods for Performance and Efficiency Tests on Industrial Plant.

In the course of the preparation of these standard methods a good deal of experimental work has been done to establish that consistent results can be obtained by the methods described before they were adopted. The sampling section embodies an important development in the theory of sampling inasmuch as it takes stock both of the error involved in the collection of the gross sample and the aggregate error involved in reducing the gross sample to a suitable weight for examination in the laboratory. Full particulars have been included in an Appendix of suitable approved forms of sample dividers for sample reduction.

This British Standard is not intended to replace B.S.S. 420-1931 or B.S.S. No. 496-1933, which were prepared to meet the requirements of buying and selling of coal and coke. Rather is it an extension, with special provision for the greater accuracy called for in plant performance tests. Due regard has, of course, been given to the better facilities for sampling and supervision which are generally available at plant tests. In the case of coke, the classification given in B.S.S. No. 496-1933 has been amplified in order to make more exact provision for sampling.

The present standard has also been extended to provide for greater accuracy than ± 1 unit and weights of gross samples for accuracies of ± 0·75, ± 0·50 and ± 0·25 are also shown. Proximate methods of analysis are included for both coal and coke, together with certain special tests for coke as the thermal value of volatile matter, the Trommel, shatter test, &c. Copies of this Specification (B.S.S. No. 735-1937) may be obtained from the British Standards Institution, 28, Victoria Street, S.W. 1, price 3s. 6d. (3s. 8d. post free).

Forthcoming Engagements

Sept.

16.—Wales and Monmouthshire Association.—General Meeting at Porthcawl.

16.—I.G.E.—Gas Education Executive Committee, 11 a.m.; Refractory Materials Joint Committee, 2.30 p.m.

20.—London and Counties Coke Association.—Executive Committee, 11.15 a.m.; Central Committee, 2.30 p.m.

23.—S.B.G.I.—Council Meeting, 11 a.m.

24.—I.G.E.—Joint Lighting Committee, 2.30 p.m.

26-29.—B.C.G.A.—Annual Conference at Manchester.

30.—I.G.E.—Gasholder Committee, 2.30 p.m.

Oct.

1.—I.G.E.—Liquor Effluents and Ammonia Committee, 11.15 a.m.; Joint Research Committee, 2.30 p.m.

5.—I.G.E.—Research Executive Committee, 2.30 p.m.

5.—Southern Association of Gas Engineers and Managers (Eastern District).—Commercial Meeting at Gas Industry House, 2.30 p.m. Discussion on Gas Mixing. Committee Meeting, 12 noon.

7.—I.G.E.—Joint Committee on Complete Gasification under Pressure, 3 p.m.

7.—Southern Association.—Meeting of General Committee, Gas Industry House, 2.30 p.m.

8.—North of England Association.—Autumn Meeting at Willington.

12.—I.G.E.—Board of Examiners, 10.30 p.m.

13.—I.G.E.—Finance Committee, 9.30 a.m.; Membership Committee, 10 a.m.; General Purposes Committee, 11 a.m.; Benevolent Fund Committee of Management, 12.30 p.m.; Council, 2.30 p.m.

13.—Coke Salesmen's Circle.—Meeting at Gas Industry House, 2.30 p.m.

14.—Eastern Counties Association.—Autumn Meeting at Bedford.

19.—I.G.E.—Gas Education Executive Committee, 11 a.m.; Gas Education Committee, 2.30 p.m.

26.—B.C.G.A.—Eastern District Conference at Lincoln.

27.—B.C.G.A.—Northern District Conference at Darlington.

28.—Coke Oven Managers' Association.—Annual Dinner, Hotel Victoria, London.

Nov.

2.—I.G.E.—Council, 9.30 a.m.; Council (*continued*), 4.30 p.m.

2 and 3.—I.G.E.—Autumn Research Meeting.

3.—British Gas Federation.—Annual General Meeting and Dinner, Grosvenor House, Park Lane, W. 1.

19.—Southern Association.—General Meeting, Hotel Victoria, 2.30 p.m. Paper by W. A. Bishop (Croydon) on "Large-Scale Heating by Gas." Committee meeting precedes at 12 noon.

New Gas Plant Inaugurated

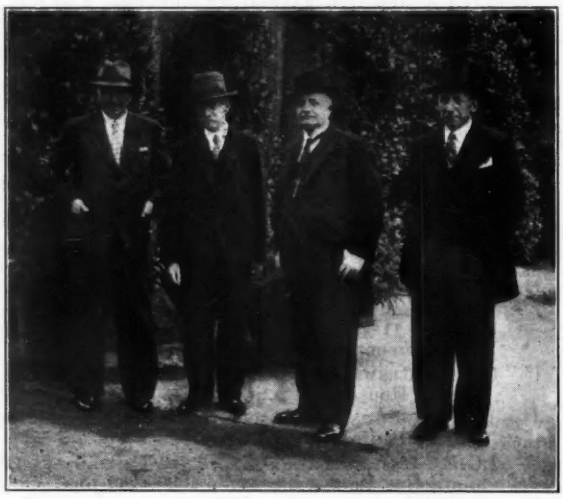
AT COPENHAGEN

The Eastern Gas-Works from the Air.

For this comprehensive article, descriptive of the Copenhagen Gas Undertaking in general, and in particular of the extensions at the Eastern Gas-Works, we are primarily indebted to Mr. Börresen, Director of the Lighting Department, at whose cordial invitation the "GAS JOURNAL" was represented at the inauguration celebrations by Mr. Clifford King.

The Copenhagen Lighting Department (Gas and Electricity Works) celebrated the extensions recently carried out at the Eastern Gas-Works by a formal inauguration on the afternoon of Saturday, Sept. 4. The extensions comprise an installation of "Westvertical" retorts (5½ million cu.ft. per diem capacity), additions to the condensing and exhausting plant, a Holmes benzole recovery and a "Dri-Gas" plant, a Kent shunt meter, together with other plant specified in the course of this article.

It was fortunate that the function coincided with the official visit to Copenhagen of the Lord Mayor of Manchester, Alderman J. Toole, for one of the features of his six days' extensive programme was the act of formally putting the plant into operation. The Eastern Gas-Works was gaily decorated for the occasion and bunting and flowers formed a background for the actual ceremony which was performed in the retort house. The official speeches were broadcast.

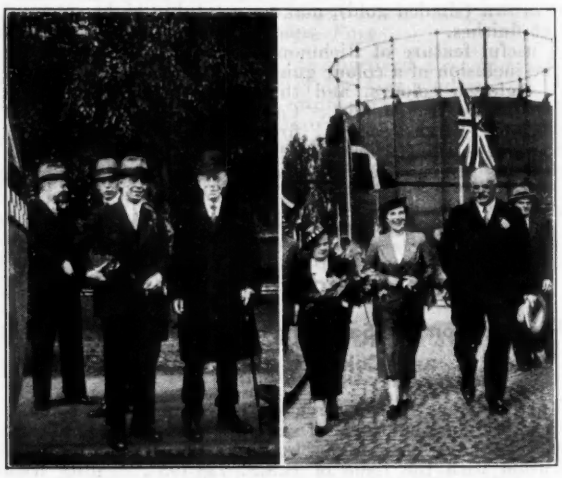


Right to left—Mr. J. E. Börresen, Burgomaster Andersen, Mr. J. F. Edelberg, and Mr. Julius Hansen.

The assembly, in addition to the Lord Mayor's party, included the President of the Copenhagen City Council, Burgomasters, Aldermen and Councillors of the Municipality, representatives of the workmen, and various official visitors. Of the officers of the Gas Undertaking there were present Mr. J. E. Börresen, Director of the Gas and Electricity Works; Mr. J. F. Edelberg, Chief Engineer to the Gas Department; Mr. Julius Hansen, Distribution Engineer; Mr. B. Öllgaard and Mr. R. Jakobsen, Engineer and Manager and Deputy Engineer respectively of the Eastern Gas-Works. Among the visiting gas men were Mr. Irminger, Senior, late Engineer at Copenhagen and now carrying a modest 89 years; Mr. John Irminger, of Bergen; and Mr. Westenholz, of Strandvej. Sir Frederick J. West, Mr. Frank West, and Mr. P. Roberts represented West's Gas Improvement Company, Ltd.

The Opening Ceremony.

Burgomaster Andersen extended a welcome to the assembly and invited Sir Frederick West to hand over the plant officially. This he did, remarking that it was 42 years since his firm carried out their first contract with the Lighting Department, during which period great progress had been made in carbonizing processes. To-day, mere muscle and physique were no longer essentials for the ordinary duties of the retort house; the application of brains and technical knowledge on the part of the workmen and officials were absolute necessities to obtain the highest efficiency. It was satisfactory to him and those associated with him that they had always obtained in



Sir Frederick West is in the right-hand snap with a Councillor of Copenhagen and Mrs. Moss, daughter of the Lord Mayor of Manchester. In the other picture are Mr. John Irminger and his father, with Mr. Jakobsen, Deputy at the Eastern Gas-Works, behind.

Copenhagen the willing co-operation and keen and active interest on the part of the operators of the plant and the officials in charge. Such co-operation had a vital effect on enterprises of that nature and had resulted in operating the plant in the most efficient manner.

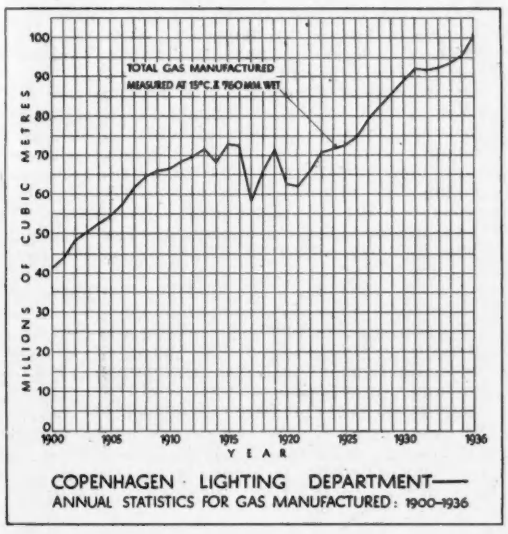
Mr. Börresen accepted the plant, remarking that he was convinced the Lighting Department had obtained an installation which in every respect would justify the promises given by the Contractors, and would give every satisfaction in the future. The plant had worked satisfactorily since it was put into operation, and the coke which was produced had excellent properties and was readily sold. He expressed his pleasure at being able to show the extensions to such a large number of visitors. The Department felt it was a great honour that the Lord Mayor of Manchester had undertaken to inaugurate the plant.

The Lord Mayor then officially opened the installation, stating that it was gratifying that one of the first functions of his official visit to Copenhagen should be in connection with a most important public utility service. With his experience, arising from a 20 years' membership of the Manchester Corporation Gas Committee, he realized the extent to which gas entered into the comfort and enjoyment of home life, and its importance to commercial and industrial development. In his speech, and at the inaugural reception later in the afternoon, he paid a gracious compliment to the Manchester firm responsible for the greater part of the extensions and to their Chairman and Managing Director. Sir Frederick West he associated with everything that is good and straight and honest.

After inspecting the plant, the visitors were conveyed to a reception at the Trades Guildhall.

THE GAS UNDERTAKING.

The Köbenhavns Belysningsvæsen, or Lighting Department, is responsible for the supply of both gas and electricity within the City of Copenhagen and while both sections preserve a competitive spirit, they share the benefits



COPENHAGEN LIGHTING DEPARTMENT—
ANNUAL STATISTICS FOR GAS MANUFACTURED: 1900-1936

of being directed from the same source. During the past few years the Municipality have adopted a scheme of reconstruction which has involved the building of new electricity works and modernization of the gas-works.

The Gas Department, as their part of the scheme, have endeavoured to centralize manufacture as much as possible, and in consequence the entire supply of gas for the city is produced at two works—Eastern and Valby. The older works at Western and Sundby have been closed down; the former in 1927 after being in continuous operation since 1857, and the latter during the present year.

The growth of the Gas Undertaking can readily be seen from the graph of the statistics reproduced herewith, from which it will be noted that the gas manufactured for the year ended March, 1937, reached the record total of over 100 million m³, or 3,540 million cu.ft. Over the past ten years there has been an increase of no less than 34½% in the quantity manufactured. The industrial load is not more than 25% of the total delivered, and the remaining 75% used for purely domestic purposes is sold to the ordinary consumer at a price of 15 öre per m³, or 9d. per therm. It is expected this price will be reduced to 13 öre per m³ in the near future. The Gas Department contributes yearly to the finances of the Municipality an amount equivalent to over £100,000.

Eastern Gas-Works.

These were built in the period 1876 to 1878, and are, since reconstruction, the largest of the Municipality's remaining stations. They are well situated on the waterfront for the reception of the steamers conveying coal to the Department's wharf.

Prior to 1935, the plant for the manufacture of coal gas consisted of an installation of Glover-West continuous vertical retorts with a maximum daily production of 90,000 m³ (3,175,000 cu.ft.), and this was supplemented by a Humphreys & Glasgow C.W.G. plant with a daily capacity of 45,000 m³ (1,600,000 cu.ft.). This constituted the stand-by for the abnormal gas consumption which usually occurs on Christmas Eve each year—abnormal in the respect that it is more than 40% greater than the volume supplied on the maximum day for the rest of the year.

In 1933 a scheme of reconstruction of the Eastern Gas-Works was decided upon, and tenders were called and accepted for the following plant:

(*a*) Retort bench, capacity 5½ million cu.ft. per day.

(*b*) Coal blending, mixing, and handling plant, 100-tonnes output per hour.

(*c*) Water softening plant, maximum 40 tonnes hard water per hour.

(*d*) Tar and liquor well, with separator, 4,200 tonnes.

(*e*) Water tube condensers—400,000 m³ per diem from 100° to 18° C.

(*f*) Turbo-exhausters, 10,000 m³ per hour.

(*g*) Station meter.

(*h*) Benzole washers capable of washing 4,200 litres of crude per day, with refining plant for the production of 5,000 litres 90's per day.

(*i*) Dry gas plant (calcium chloride system) with a total capacity of 20,000 m³ per hour.

(*j*) Thomas calorimeter and instruments.

The New Carbonizing Plant.

The contract for the new carbonizing plant and supplementary machinery for coal blending and mixing has been carried out by West's Gas Improvement Company, Ltd. The installation consists of forty Westvertical chambers, 100 in. by 10 in. at the top, and these are arranged in ten settings. The chambers are in units of two, and the heating is carried out by a system of five horizontal combustion chambers followed by five circulating chambers. By this system the zoning of the heats to suit the intermittent process can be more accurately controlled.

The ten settings are heated by producer gas generated in a battery of ten step-grate producers, which are separate from the retort bench and connected by a series of connecting flues. As a whole battery is also fitted with a common flue, with dampers for shutting off individual units, it is possible to effect repairs to any producer without interfering with the gas requirements for the heating of the settings.

Each producer connecting flue to the settings is fitted with a pipe for the introduction of coal gas at such times as it is considered profitable to release as much coke for sale (which would otherwise be used as fuel) as possible. The Lighting Department's Engineers have carefully studied this problem and have evolved the system of mixing coal gas with the producer gas in the manner indicated, and with satisfactory results.

The Westvertical system has been described in detail in the "JOURNAL" on previous occasions, but it should be stated that the *primary object of the adoption of this system in Copenhagen was the suitability of the coke produced for the existing central heating systems in Denmark and the domestic stoves commonly used in the Danish household.* Coke is usually delivered and sold to the consumers by measure, the standard demanded being a density of 40 to 43 kg. per hectolitre. The installation described is regularly producing coke of the prescribed density and quality.

Two waste-heat boilers, of the Spencer-Bonecourt type, have also been installed for the recovery of the surplus heat in the waste gases. These boilers are capable of evaporating 10,000 kg. of water per hour from and at 100° C.

The coal blending and mixing plant, which was designed by the Lighting Department's own staff and erected in connection with the new carbonizing plant, was also delivered by West's Gas Improvement Company, Ltd. This plant includes many of the West specialities such as elevators, breakers, conveyors, &c.

After the installation had been in operation some months a test was carried out by the Lighting Department with

the following satisfactory results. These results generally substantiate the guarantees, the coal being of a slightly inferior quality to that specified:

Details of Guarantee Tests.

Period of Test—7 days.

Coal—The coal carbonized consisted of a mixture of 50% Consett (Durham) coal, and 50% Wearmouth (Durham) with the following analysis:

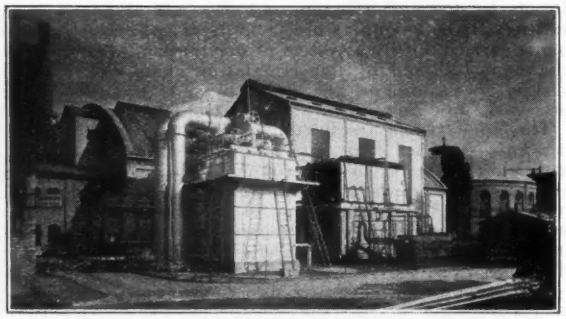
—	Consett.	Wearmouth.
Moisture	3·3%*	2·7%*
Ash	6·7 ,,	6·2 ,,
V O M.	27 8 ,,	31·5 ,,
Fixed C	62·2 ,,	59·6 ,,

—	Metric.	British.
Total coal carbonized (wet)	2,173 tonnes	2,138 tons
Coal carbonized per charge (wet)	3,030 Kg.	2·98 ,,
Coal carbonized per chamber per 24 hours	8,790 Kg.	8·65 ,,
Gas—		
Total gas manufactured measured at 15° C. and 760 mm. wet	948,300 m³	33,484,470 cu.ft.
Gas made per 1,000 kg. wet coal carbonized	436·4 m³	15,660 cu.ft./ton
Gas made per 1.000 kg. coal (corrected to 2% moisture content)	446·2 m³	16,009 ,,
Calorific value of gas made during test measured at 15° C. and 760 mm. wet)	4,546 K.cals. per m³	511 B.Th.U./cu ft.
Therms per ton	..	81·8 therms
Fuel—		
Fuel consumption (after allowance for surplus steam produced)	13·2%	13·2%

* Moisture in actual coal elevated, 4·2%.

Auxiliary Plant.

The plant which was installed at the same time as the extensions to the retort house was mainly supplied by English firms. Messrs. W. C. Holmes & Co., Ltd., of Huddersfield, had previously carried out a considerable amount of work at both the Eastern and Valby Works, having supplied the washing plant when the latter were



The Holmes Benzole Refinery and Gas-Drying Plant.

built in 1905, and a number of installations of similar kind for extensions at both Works since that time. For the extensions which are the subject of the present article Messrs. Holmes have supplied water-cooled condensers of the Holmes "Super" type; gas dehydration plant (Drigas system); Holmes "Multifilm" washers for benzole and naphthalene extraction and gas drying; crude benzole recovery plant at both Works, and a complete rectification plant at the Eastern Gas-Works. The contracts were carried out by Messrs. Holmes in collaboration with their Danish agent, Ingenieur Hans Buch, of Copenhagen.

The exhausters are of the well-known Rateau-turbo type manufactured by the Bryan Donkin Company, Ltd., of Chesterfield.

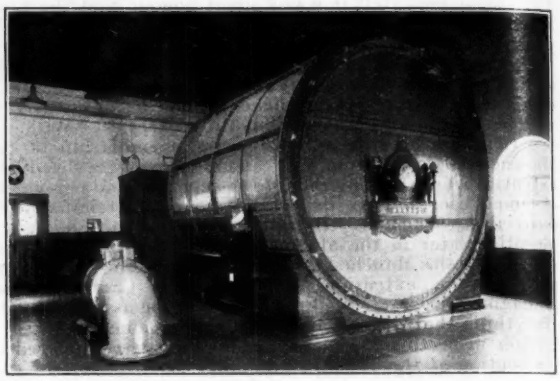
The station meter, which is capable of dealing with 10,000 m³ of gas per hour, is here shown erected against one of the older types of wet meter, the capacity of which is less than half that of the new shunt meter installed. Messrs. George Kent & Co., Ltd., supplied the new meter together with recorders for registering the gas flow. A further addition which has been contributed by an English firm is that of a Thomas recording calorimeter supplied by the Cambridge Instrument Company, Ltd.

The entire scheme of reconstruction has been carried out in a little under four years, and has involved several interesting problems in erection. The whole has been carried out by Danish labour and over 75% of the materials used in the construction were fabricated in Copenhagen workshops.

THE DISTRIBUTION SIDE.

When the first gas-works was erected in Copenhagen in 1857, the town was still concentrated, and distribution of its gas did not incur many difficulties, though the fact that the harbour broke the area of supply necessitated laying a 12-in. main in a tunnel.

Until 1914 gas was supplied by means of low-pressure cast-iron mains joined by sockets and lead casting. However, growth of the town in size and population necessi-

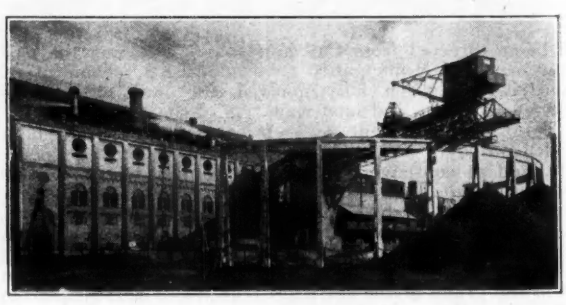


The New Kent Station Meter—Capacity, 10,000 M³. Alongside is one of the two old Station Meters.

tated large (up to 42 in.) and costly low-pressure mains, and in 1914 the first compressing plant was installed. Since then a high-pressure system has been established having a total length of about 35 kilometres (22 miles) and consisting of insulated welded steel pipes with socket and spigot joints. During recent years, however, cast-iron mains with Stanton-Wilson joints and rubber packing have been more and more adopted.

In the two largest gas-works at Copenhagen, which are situated on the Northern and Southern outskirts of the city, there are pumping stations able to send out gas at a pressure up to 5 m. (196·8 in.) water-column. These two works are interconnected by the high-pressure network, leading under the harbour at two points, and with another pumping station situated in the centre of the town. There are 10 compressors in all, having a maximum capacity of about 33,000 m³ (1,165,340 cu.ft.). There is a wet gasholder in one of the suburbs of 30,000 m³ (1,059,400 cu.ft.) capacity which can be filled from the high-pressure network. The dimensions of the pressure pipe lines vary from 150 to 400 mm. (5·9 to 15·7 in.). There are now 15 automatic pressure regulators, reducing the initial pressure to about 100 mm. (3·9 in.) water column, which is the maximum pressure in the mains.

As already stated, the town has developed so rapidly that the Copenhagen Gas-Works now supply a population of about 700,000 inhabitants. During the last ten years there has been a pronounced tendency for people to abandon flats in the centre of the town and move into villa



The "Westvertical" Installation and Coke Yard.

residences in the suburbs, so that the present area of supply is in the neighbourhood of 90 sq. kilometres (34 sq. miles). This has necessitated the installation of large mains, the total length of which now amounts to 806 kilometres (548·6 miles). The minimum main dimension is 4 in. Cast-iron pipes with socket joints are still employed.

The illumination of streets in the inner town is chiefly

by gas, while the suburbs are principally lighted by electricity. An endeavour, however, is being made to meet the competition by supplying lamps and burners of modern design, and there are about 6,600 public gas lamps in Copenhagen, consuming annually about 6·8 million m³ (214,715,800 cu.ft.) of gas.

Gas services leading to individual premises were previously laid of cast-iron, but insulated steel pipes joined by screwed spigot and sockets are now exclusively used. No outside stop cocks are fitted, but a house stop cock is fitted on the pipe after entry to the house. The smallest dimension used is 1½ in. The number of services in Copenhagen is about 30,000.

The work in connection with mains, public lamps, services, &c., is carried out by the gas-works, who also deal with house services before the meter in large premises and install as well as maintain meters, which are all of the dry type. A total of about 254,000 meters is installed in Copenhagen, the average annual gas consumption being 354 m³ (12,500 cu.ft.) per meter.

All other work concerning installations is carried out by approved private gasfitters who, under the control of the gas-works, carcass premises and install all gas appliances in conformity with existing rules.

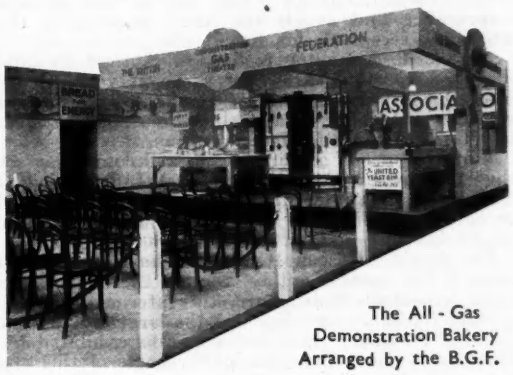
The gas-works give their consumers an extensive service as regards the adjustment and operation of gas appliances, and also render assistance by sending skilled operatives to repair minor defects. Service includes the staging of lectures and demonstrations by experts and trained ladies who also undertake home-service calls. A large demonstration department for gas and electricity has been established in the administration offices of the Copenhagen Lighting Department, and a special demonstration workshop for large industrial ovens and appliances has been organized. No sale of appliances, however, takes place in these premises.

Last year the total output of the Copenhagen Gas-Works amounted to about 97·2 million m³ (3,423 million cu.ft.) with a calorific value of approximately 4,500 kg. C. per m³ (505 B.Th.U. per cu.ft.).

As stated above, about 6·8 million m³ (214,715,800 cu.ft.) of gas is consumed for street illumination purposes. The balance of gas sales amounted to approximately 88·7 million m³ (3,132 million cu.ft.)—an increase of about 4·4% on the previous year. Industrial sales were about 15·3 million m³ (540 million cu.ft.). It will be seen, therefore, that private households account for the major consumption—the annual consumption per inhabitant being about 132 m³ (4,661 cu.ft.).

By means of new gas tariffs—a two-part tariff for households and a sliding scale for industrial consumption—the adoption of which by the Town Council is pending this autumn and whereby gas prices will be considerably reduced—the management of the Copenhagen Gas-Works hope to bring about a further increase of gas consumption during the coming year.

GAS PRE-EMINENT FOR THE BAKERY TRADE



The All-Gas Demonstration Bakery Arranged by the B.G.F.

Fine Display at the Bakers' and Confectioners' Exhibition

Once again the pre-eminence of gas for the bakery trade was forcefully demonstrated by a series of fine displays by the British Gas Federation, the Gas Light and Coke Company, and leading appliance manufacturers at the forty-first Bakers', Confectioners', and Allied Traders' Exhibition, held at the Royal Agricultural Hall, Islington, from Sept. 4 to 10.

For the first time at this Annual Exhibition, which is proving more and more popular year by year, a display was arranged by the British Gas Federation. This consisted of a large demonstration theatre in the Gilbey Hall, where continuous demonstrations were conducted by a Gold Medallist baker on a platform which represented the very latest type of all-gas bakery. The actual baking was done in a "Dumbrill" hot-air oven, all kinds of goods being prepared, while ancillary equipment included a "Thermspray" boiler, and a gas refrigerator.

Excellent attendances were recorded at these demonstrations, and a point was made of emphasizing the special gas rates offered to the bakery trade by all the leading gas undertakings in the London area and elsewhere. While stress was laid upon the many advantages of installing a specially designed gas baking oven, the value of gas conversion sets was pointed out as a means to an end—to get the baker initially interested in, and convinced as to the benefits of, gas for his various purposes.

In the main hall a compact yet striking little display was arranged by the Gas Light and Coke Company, showing the many ways in which gas can be utilized for all kinds of baking as well as for cake and pastry making work. A series of large photographs round the stand gave an idea of the type of equipment available, while a model of a side flue oven that had been converted to gas showed how easily ovens already being used with other types of fuels can be adapted to this more reliable and up-to-date form of firing. The G.L.C. doughnut frier, capable of turning out 1,000 doughnuts per hour, was shown, while automatic gas water heating—so essential a perquisite of the modern bakery, both for dough-mixing work and washing up—was represented by an "Equator" storage heater. Also shown was a special appliance for fondant heating.

The "Thermspray" boiler, for injecting wet steam into ovens of any type, was exhibited, while larger sizes of gas-operated refrigerators exemplified the type of appliance suitable for the bakery. In addition, attractive gas radiators were shown, these complying with the requirements of the Shop Act, for use in bakers' and confectioners' shops. The lighting of the Gas Light and Coke Company's stand was effectively carried out with pleasing chromium-plated fittings.

Modern Apparatus.

A number of manufacturers of bakery apparatus included in their exhibits modern designs of gas ovens and ancillary equipment, of which the following may be mentioned:

Baker Perkins, Ltd., were showing their two-deck portable peel oven, with chambers fitted for gas firing, while Thomas Collins & Co., Ltd., exhibited their "Gas-de-Luxe" direct heat type oven, which is constructed on up-to-date lines.

A feature of the display of Cox Ovenbuilders, Ltd., was their new "Double-Degree" "Super Heat-Trap" gas oven. This oven is built with independent firing to each deck, so that it is possible to heat both decks equally or to bake high-temperature goods (up to 500°) in either of

the decks and lower temperature goods (say, 250°) in the other deck simultaneously. The control of this oven is particularly simple, there being only three taps altogether situated conveniently at the front of the apparatus, so that there is no necessity to get at either sides or back in order to operate the oven. The air control is automatic, and it is stated that the burners cannot fire back.

This firm showed, in addition, dummy fronts of coke-fired and other gas-fired ovens, all very smart in their grey mottled enamel finish. The " Super Heat-Trap " is built to suit almost any requirements, varying in sizes from 9 ft. by 7 ft. to 33 in. by 20 in. baking space, while single or decker, peel or drawplate, portable or brick-built are available. A valuable point claimed for the Cox oven of this type is its low maintenance costs, and it is stated that the total cost of the whole of the repairs to these " Super Heat-Trap " models over fifteen years has averaged only 1s. 9d.% per annum on the cost of the ovens. These ovens employ luminous burners, the hot products rising up under the oven floors and forcing the cold air down—a method of heating which gives high efficiency for the fuel consumed

The Gas Light and Coke Company's Stand.

and time worked. Cox ovens, indeed, are claimed to stand up to the most exacting tests of any class of baking—as a result of scientific investigation over many years.

A new type of gas-fired baking oven—the " Supergas "—was shown on the stand of the Dumbrill Plant and Engineering Company, Ltd., incorporating important improvements in design which ensures an even, solid, and continuous heat, with no hot or " dead " spots. The scientific arrangement of heat circulation through the brick-built ducts assures complete use of gas with great economy. This firm make the " Uniheat " hot-air oven and a portable steam-tube oven, both providing separate heat control for each deck, with thermostatic control if desired. Dumbrill's hot-air and heat-trap ovens are available from 3 ft. square up to the largest sizes, while they also build solid brick steam tube ovens, together with two and three deck portable models. The firm have recently completed a large installation for the Army and Navy Stores' bakery.

A comprehensive display of gas-fired equipment was exhibited on the stand of the Ellerstyle Engineering Company, Ltd., including Vienna ovens, two and three deck portable peel ovens, the " Thermtrap " Junior gas-fired oven, the " Thermspray " boiler, and gas light-boxes for illuminating the interior of ovens.

The Ellerstyle " Thermtrap " brick-built oven is another example of expert oven design, the entire brick structure having a Diatomite insulation insert, which conserves the heat in the oven. The structure is bonded and braced in each direction, and the baking chambers are lined with glazed bricks, providing a surface which will not absorb moisture. The main gas cock and main damper are properly interlocked, assuring closing of flues when gas is not required.

Examples are shown of the firm's well-known " Thermspray " boiler, whose patent single valve control provides the required humidity in the oven and avoids the necessity of making adjustment to prevent excess of water vapour. The " Thermspray " boiler is gas-fired and of special construction, including an automatic regulator or " pressurestat " which controls the gas when steam is generated, cutting down the gas and preventing waste of steam when the boiler is up to its working pressure of 28-30 lb. When fresh water is injected into the boiler to make up the loss by steaming the " pressurestat " automatically turns up the gas. Ellerstyle's have recently developed a doughnut frier of considerable interest. Its sound construction, neat appearance, and efficient operation will make it a useful addition to the equipment of the bakery—particularly where space is limited.

This firm also make gas-fired conveyor ovens, with a provision for any rate of travel of the conveyor chains or belts to give definite baking periods. The extended use of steam in ovens renders the old-fashioned gas flare useless, and efficient oven lighting by gas is now provided on Ellerstyle ovens, properly switch controlled from the front of the oven. The construction of the light-box is cast-iron throughout, while the heat-resisting lens is easily removed when required. The door in front gives a clean appearance and avoids the usual opening in the wall, which is a receptacle for dirt.

Messrs. T. Errington & Sons, Ltd., had an interesting display of portable ovens for the bakery trade, while the Four Oaks Spraying Machine Company were showing limewashing and dough-spraying machines, sprayers, and disinfecting machines for bakers' ovens.

Various types of gas-fired ovens and conversion sets were shown by Kent & Co. (Globe Works), Ltd. Their " Globe " models are built in a variety of types and sizes, brick-built or portable, while they also make steam tube ovens both solid brick-built and portable.

The firm's " Gascon 1G " ovens have been designed to incur a low capital outlay, though the saving in cost is made in outside finish only, the internal parts being of exactly the same high finish as the larger " 3G " model.

The " Portway " portable oven was exhibited by Chas. Portway & Son. The principal features of this appliance are simplicity in fixing, economy in gas, with an increased baking surface.

On the stand of Thomas & Bishop, Ltd., was a display of the firm's belt dressing, metal-to-metal jointing material for joints of all kinds, furnace cement for use in the construction and repair of bakers' ovens, tinning compounds, lubricating grease, leather and textile belt treatments, and other accessories of use to the baker or oven-builder.

Once again this Exhibition clearly shows the great progress which has been and is being made in putting the gas bakery on the map. With the continued co-operation of the oven-builders in producing more and more efficient apparatus, and of gas undertakings in selling cheaper and cheaper gas for baking purposes, a very valuable load may well be built up for the Industry.

A New House Organ

The " Cambridge Gas Bulletin "

We welcome this month a newcomer to the ranks of gas company house organs—the *Cambridge Gas Bulletin*—a bright little publication, with a cover of the appropriate shade of blue.

In a foreword to No. 1 the Chairman of the Cambridge University and Town Gas Light Company (Mr. J. F. Cameron) remarks that in publishing the *Bulletin* the Company are following the example of many industrial concerns who have found that a magazine of their own is appreciated by those who work for them. The *Bulletin* starts in a modest way; it does not run to many pages, and, at least to begin with, it is not proposed to publish oftener than four times a year. It will, nevertheless, serve the purpose for which it is planned, which is to inform all those who are associated with the Company of its affairs—past, present, and future—and to interest them in these affairs.

Without being too technical, the *Bulletin* will give descriptions of new plant and apparatus; it will deal with the affairs of the Company's Recreation Club and Co-partnership Scheme, and it will not be above making a note of matters of more strictly personal interest.

In a few subsequent words the Engineer and Manager (Mr. J. Hunter Rioch) refers to the new venture as a means of linking the various units of the Company more closely together with a view the more easily to keeping abreast of developments.

We wish the *Cambridge Gas Bulletin* and its Editor (Mr. Wosencroft) all success in their useful work.

North British Association of Gas Managers

Annual Meeting at Edinburgh

The 76th Annual General Meeting of the North British Association of Gas Managers was held in the Freemasons' Hall, George Street, Edinburgh, on Thursday and Friday of last week, Sept. 9 and 10, Mr. JAMES JAMIESON, President of the Association, in the chair.

The Proceedings opened with a civic welcome, given to the delegates on behalf of the Edinburgh Corporation by Councillor Walter Muter, J.P., Chairman of the Public Utilities Committee of the Edinburgh Corporation, and Councillor William Duncan, J.P., Convener of the Corporation Gas Committee.

The PRESIDENT said he was gratified to see such a large attendance. It was his earnest wish that the members would have a happy and pleasant time in Edinburgh. They had departed from the usual practice by having two forenoon sessions instead of one full day's business. This meant the elimination of the morning excursion usually held at their meetings, but they would find a visit to Edinburgh was an excursion in itself. They would be able to utilize the free afternoon as they chose.

Councillor MUTER said he was in the unhappy *rôle* of a substitute. The Lord Provost had hoped to be present to give them a formal and official welcome, but urgent public business prevented him attending. As Chairman of the Public Utilities Committee responsible for the government—he hoped it was the good government—of their trading departments, he had been charged with the duty of extending to them a warm welcome to Edinburgh. He hoped their visit would be full of interest, both from the point of view of the proceedings at their meetings, and also from the point of view of being able to visit some of the interesting spots in their beautiful city.

Continuing, Councillor Muter said he was glad that their Association, now a lusty child of some 76 summers, was meeting in Edinburgh. Since the Corporation there took over direct charge of the gas undertaking in 1920 they had gone from strength to strength. They were proud of their undertaking and specially proud of and grateful to the Gas Engineer and Manager, Mr. Jamieson, who was their President. Public servants were not often eulogized. More often they were the targets for ill-natured criticism from every quarter. But, especially in the Gas Department, there was a happy relationship between the Corporation of Edinburgh and its officials. He was not indulging in undue flattery. They knew Mr. Jamieson's value to themselves and to the Industry as a whole. Along with Dr. King, his efforts with regard to the cannel coal question had proved a national, if not an international, contribution to Gas Industry, while he had also carried out experiments in connection with the weathering of coal, the results of which would be awaited with interest throughout the country.

The fullest collaboration in the national sense was of extreme urgency and importance, said Councillor Muter. He himself had played some little part in the Gas Industry in Scotland, but they could not rest content when they found that certain important undertakings were not in their ranks and others were not in full membership. It was not only membership but full co-operation that was required. He had the greatest possible pleasure in welcoming them and in hoping that their deliberations would be fruitful.

Councillor WILLIAM DUNCAN, J.P., also extended a greeting to the Association.

The PRESIDENT, in acknowledging the welcome, said Councillor Muter had given excellent service in many ways and particularly as President of the British Commercial Gas Association. His pleasing personality, his platform appearances, and his great interest had combined to help the Industry to its rightful place. Councillor Duncan had also taken a deep interest in the work and would prove a worthy successor to Councillor Muter. He thanked both speakers for their references to himself and for their cordial welcome to Edinburgh.

The minutes of the last meeting were taken as read and approved.

Reference was made by the President to the recent death of Mrs. Braidwood, who would have been their hostess at their next gathering, and the members stood in silence for a moment in respect to her memory.

Apologies for absence were intimated from the presidents and secretaries of various kindred associations and from members of the Association.

The PRESIDENT said he had pleasure in welcoming Mr. H. C. Smith (President of The Institution of Gas Engineers) and Dr. W. T. K. Braunholtz (Secretary of the Institution), also Mr. S. E. Whitehead (President of the Southern Association).

Mr. H. C. SMITH expressed his pleasure at visiting Edinburgh. When he became Vice-President of the Institution one of the first invitations he received was to give an Address to the combined Scottish Junior Associations in the Royal Technical College, Glasgow. It was a foggy day but the room had been crowded, some of those present having come considerable distances, and it was one of the best Saturday afternoons he ever remembered. He had therefore made up his mind to accept any invitation that came to visit another Association in Scotland. He thanked them for their kind welcome.

The President, Mr. James Jamieson, of Edinburgh, and Dr. J. G. King.

Mr. S. E. WHITEHEAD thanked the Association for their invitation and conveyed the greetings of his own Association.

Dr. BRAUNHOLTZ said it was not his first visit to Edinburgh, but this was the first occasion he had attended a meeting of their Association. He hoped they would have in London the pleasure of meeting an ever-increasing number of their members at the annual meetings of the Institution.

The PRESIDENT said they also had with them Col. W. M. Carr, Past-President of the Institution.

The Council's Report and Financial Statement was approved, Mr. A. Kellock (the Hon. Secretary and Treasurer) intimating that the following members had been admitted to the Association since the report was printed:

Ordinary Members.—A. C. Rea (Perth); Crawford Wilson (Carluke).

Associate Member.—R. Cowie, Jnr. (Hawick).

Extraordinary Member.—C. A. Poulson (Resident Engineer, Baillieston, Glasgow).

A Section of the large attendance of delegates and visitors.

Certificates.

The PRESIDENT presented certificates gained at the 1937 examinations of The Institution of Gas Engineers as follows:

Gas Engineering—Higher Grade.

External—2nd Class.—W. M. Henderson (Cowdenbeath).

Internal—2nd Class.—J. Christie (Burntisland); D. Fyfe (Methil); L. H. W. Locke (Perth); T. Ross (Leven); J. F. Wilson (Perth).

Gas Supply—Higher Grade.

External—2nd Class.—W. M. Henderson.

Internal—1st Class.—T. P. Napier (Kirkcaldy). *2nd Class.*—A. Brown (Leven); T. B. Livingstone (Alloa); A. A. Mitchell (Dunfermline).

The William Young Memorial Lecture was thereafter presented by Dr. J. G. King (Chief Chemist of the Fuel Research Station). This will be found on other pages of this week's "JOURNAL."

CIVIC LUNCHEON.

The luncheon given in the Assembly Rooms, George Street, Edinburgh, by the Corporation was largely attended. The Rt. Hon. Sir Louis Gumley (Lord Provost of the City) presided, and was supported by the President, the Rt. Hon. Ernest Brown, M.C. M.P. (Minister of Labour), Lady Gumley, Sir Russell Bencraft (Southampton), Mr. H. C. Smith, Sir William Sleigh (ex-Lord Provost of Edinburgh), Sir William Thomson (ex-Lord Provost), and many others.

Proposing the toast of the City and Royal Burgh of Edinburgh, Sir RUSSELL BENCRAFT said that fifty years ago he had lived in the city as a medical student, attending the University from which he obtained his medical degree. He had travelled greatly but Edinburgh was the most beautiful city he had seen. Its War Memorial; Princes Street; Holyroodhouse—these were but a few of Edinburgh's fine possessions. He had been over the gasworks with Mr. Jamieson and had come to the conclusion that they were one of the finest in the United Kingdom. As regards Scotsmen, wherever there was a good job across the Border, there you found a Scot. On his own Board there were two Scotsmen—one of them Mr. Thomas Carmichael. He congratulated Sir Louis on the honour of knighthood that had recently been conferred on him and coupled the toast with his name.

Sir LOUIS GUMLEY, replying to the Toast, expressed pleasure at the progressive North British Association holding its meeting in Edinburgh. Since its inception 76 years ago it had met more than a score of times in that city, and it was fitting that their meeting should be held there when their President was Mr. Jamieson, the much-respected Gas Engineer and Manager of Edinburgh, who was the sixth official in his position in Edinburgh to occupy their presidential chair.

Edinburgh had always been in the van of technical progress in regard to its trading undertakings, and the gas undertaking was no exception to the rule. Mr. Jamieson, by his contribution to scientific knowledge in relation to the extraction of oil from coal, had worthily upheld a high tradition. A great amount of patient observation and careful analysis was involved in modern research, and the Edinburgh Town Council was always pleased to see that their choice of responsible officials was justified.

During the last 25 years the progress of the Gas Industry had been truly remarkable, despite competition. There was one shadow, however, on the horizon. His feeling was that the significance of the Gas Industry to the coal trade was not being sufficiently realized. Their Industry performed the function of retailing in a cheap, convenient, and acceptable form, the coal from which its product was derived. If that were admitted, he would be reluctant to think that the Gas Industry should ever be the subject of exploitation by the coal industry merely on the grounds that the gas business was so well organized that it could afford to pay a little more for coal. There was a fable about the goose that laid the golden eggs. The coal industry should consider its policy seriously.

"The Gas Industry."

Proposing the toast of "The Gas Industry," the Rt. Hon. ERNEST BROWN said that people were inclined to take for granted the benefits conferred—at a price—by the Industry in the shape of light, heat, and power. Most people knew that gas came from coal and was stored in some rather inartistic erections on the outskirts of towns. Of the industry itself they knew nothing; yet its figures were astronomical. Its statutory undertakings had an authorized capital of over £250,000,000, made gas last year to the extent of almost 275,000 million cu.ft., and supplied close on eleven million consumers. That vast and essential Industry had been built up entirely in a little over a hundred years. There had been experiments early in the 18th century on the production of what Dr. Hales called "Elastic Inflammable Air." Later they had the pioneer work of William Murdoch, who "amused himself by making gas from coal on an open fire, using a kettle for a retort"—apparently living to tell the tale! It was in 1807 that part of Pall Mall was lighted by gas and two years later there was promoted the Gas Light and Coke Company's first Bill, thus marking the beginning of a long Parliamentary association with gas. It was not to be thought, however, that Parliament readily granted statutory powers to promoting companies. The first Bill received strong opposition from merchants trading to Greenland and from firms in the whaling industry, the complaint being made that the new form of lighting would destroy the demand for oil and ruin their means of livelihood.

Parliament, said Mr. Brown, had watched the progress of the Industry closely and had taken steps to see that gas was the servant and not the master of the public. In this connection it had had the co-operation of far-sighted leaders in the Industry. The great vitality of the Industry and the unremitting energy and planning of those charged with its direction and management were seen when they realized that last year's manufacture by statutory companies was 5% greater than that of the previous year while in the same period a quarter of a million more consumers had been added. It was not too much to say that gas managers were the keystone of the arch.

The Industry, said Mr. Brown, like others, had its problems, but under the far-sighted policy of its leaders it had not only maintained its plant abreast of modern engineering advancement but was also actively engaged in modernizing the consumers' appliances. It was to be congratulated on the increasing use being made of gas for industrial purposes. Great demands had been made on the Gas Industry in recent years by other industries, and it was a credit to gas managers that these demands had been so well met. Their leaders had been active in re-

search and in providing information both for intending consumers and for the smaller gas-producing organizations. He coupled the toast with the name of Mr. H. C. Smith.

Mr. H. C. SMITH, responding to the toast, said that research work was being carried out both by the Institution and by separate undertakings. They were travelling along the road towards a perfect gas. It was, however, useless work unless they could persuade their committees and boards of directors to put the results of research to practical use. It was up to them to do all they could to get more profit from it and supply their consumers with better and cheaper gas. Mr. Smith pleaded for the best possible educational facilities for juniors in the Industry and for due encouragement being given to them to operate in a practical way any ideas they might have.

Councillor W. MUTER, proposing the toast of "The Guests," said they were proud of their gas undertaking in Edinburgh. The Lord Provost had paid a commendable tribute to Mr. Jamieson and it was deserved. Mr. Brown had given eloquent testimony to the progress and efficiency of the Gas Industry. They had to consider the consumer. The day would come when the artificial price levels which had lifted their heads in the coal industry would find their balance. They were pleased with the well-merited promotion which had come the way of Mr. Brown; but it would have been better served if he had remained as Minister of Mines and cleared up the present muddle. He hoped the Minister of Labour would report to his colleagues that public utility undertakings were grievously concerned over coal prices and were hoping for Government intervention.

Col. W. M. CARR, replying, said that Mr. Jamieson would do even greater things for the Gas Industry. They were concerned only with the consumer, and their problem was how to make gas cleaner and better for the people who relied on it. They had to supply gas and fuel in a clean way, easily burned. They were destined to supply light, as well as solid and gaseous forms of heat. They had a century of work behind them and were ready to tackle the problem of liquid, as well as solid and gaseous fuel.

Mr. GEORGE MILLS (of the L.N.E.R. Scottish Division) proposed a vote of thanks to the Lord Provost for his chairmanship.

EVENING RECEPTION.

At the reception on the Thursday evening given by the Corporation in the Assembly Rooms, the Lord Provost and Lady Gumley received the guests. His Lordship said he had a peculiar connection with the Gas Industry because an ancestor of his own, an apothecary in Clark Street, was the first man to light his shop in Edinburgh with gas, this happening in 1837.

On the Friday morning two further Papers were presented—by Mr. James Wilson (Dundee) and Mr. David Fulton (Helensburgh). These, together with the discussions which followed, will be dealt with in a subsequent issue of the "JOURNAL."

Election of Officers.

Proceeding with the business meeting the SECRETARY announced that Mr. G. Braidwood (Coatbridge) became the new President, and Mr. H. A. Aitken (Leven) became the Senior Vice-President. Mr. A. McDonald (Motherwell and Wishaw) had been elected Junior Vice-President, and Messrs. R. Fife (Kilmarnock) and J. M. Ireland (Carnoustie) had been elected members of Council.

The PRESIDENT congratulated Mr. Braidwood on his election.

Mr. BRAIDWOOD expressed his appreciation of the honour conferred on him. He would carry out his duties to the best of his ability and seek to satisfy them, though he recognized how hard it would be to live up to the standard set by his predecessors in office. His co-Directors in Coatbridge would give him every support and would ensure their comfort at the Spring Meeting.

Presentation of President's Memento.

Mr. J. DICKSON (Kirkintilloch), in handing a memento of his office to Mr. Jamieson, said that the latter had been a most worthy President. Seventeen years ago he had to perform a similar duty when he preceded him in office in the Junior Association. Mr. Jamieson and he had been students together 27 years ago in the Royal Technical College, Glasgow, and through the long years of their friendship he had learned greatly to admire him. His work both for the Association and for the whole Industry had been valuable and they believed that greater honours would yet come his way.

Mr. JAMIESON, in accepting the memento, said his work had been greatly lightened by the help of his Council and the Secretary, whom he thanked for their support.

Mr. JAMES BRIDGE finally moved a general vote of thanks, to which Mr. KELLOCK briefly replied.

Golf.

The following are the results of the Golf Circle's Autumn Competition held over the Luffness New Golf Course, near Aberlady, on Sept. 8:

Winner of Challenge Bowl and Memento.——Henry Rule, Stirling.
With a score of 86 less 7 = 79.

HANDICAP PRIZES.

Section 1.

(Handicaps up to and including 11).

1st	. . . . .	Henry Rule, Stirling
2nd	. . . . .	R. B. Waddell, Polmont
3rd	. . . . .	W. C. Campbell, Buckie
4th	. . . . .	P. Blackhall, Edinburgh
5th	. . . . .	James Brock, Glasgow

Section 2.

(Handicaps over 11).

1st	. . . . .	Alex Jamieson, Johnstone
2nd	. . . . .	Lewis Fletcher, Glasgow
Tie 3rd	. . . . .	T. F. Scott, Leslie
Tie 4th	. . . . .	R. A. McLaren, Newton-on-Ayr
5th	. . . . .	A. W. Farquhar, Fraserburgh

Mr. George A. Mitchell, Glasgow, was elected Captain.

Bowls.

The Annual Meeting of the Bowling Club was held at the Whitehouse and Grange Bowling Club House on Sept. 8, five rinks taking part.

Miss Jamieson, sister of the President of the Association, presented the prizes to the following winners: Skip, J. Cochrane (Darvel); Lead, H. Robinson (Annan); Second, J. Scobie (Stonehaven); Third, R. Allan. (23 shots up.)

The second prizes were presented to: Skip, Wm. Young (Stranraer); Lead, D. M. Macintyre (Montrose); Second, J. Young (Girvan); Third, J. Richmond (Penicuik). (13 shots up.)

Mr. R. A. Harvey (Lockerbie), President of the North British Bowling Club, expressed his thanks to Miss Jamieson for so kindly presenting the prizes.

At the Annual General Meeting held in the Club House, Mr. Wm. Mann (Stevenston) was elected President of the Bowling Club for the ensuing year.

Gas Undertakings' Results

Cleveland.

The report of the Directors of the Cleveland Gas Company for the half-year ended June 30, 1937, states the profit made during the half-year was £575, to which must be added the amount brought forward from the last half-year of £4,726, making £5,301. From this there falls to be deducted the sum of £2,000 in respect of the main from Skinningrove to Claphow, which has been abandoned during the half-year to June 30. The balance at the credit of the profit and loss account is £3,301, of which sum the Directors propose to dispose as follows: In paying a dividend at the rate of 2% per annum (less income-tax), £399, to contingent fund, £100—£499—leaving to be carried forward to the next half-year the sum of £2,802.

Peterhead.

The Peterhead Gas Department shows a balance on the year's working of £282. Carried forward from the previous year was the sum of £654, and for the current year the Department commenced with £885. It has been agreed that no change be made in the price of gas.

Stalybridge.

The annual report of the Stalybridge Gas Department for the year ended March 31, 1937, states there is a gross profit of £7,520, and after making interest and sinking fund charges and other items against the revenue account, there is a net profit of £1,006, which, being carried to the appropriation account, gives a balance of £988. These figures compare with a gross profit of £4,132 and a deficiency of £2,672 for the year ended March 31, 1936. The gas sold amounted to 161,490,100 cu.ft., compared with 160,586,000 cu.ft. for last year, an increase of 904,100 cu.ft., or 0·56%. The gas sent out as registered amounted to 178,132,421 cu.ft., compared with 174,583,108 cu.ft. for the year preceding, giving an unaccounted-for gas figure of 6·72%, against 7·98% for last year. The amount of gas used for public lighting amounted to 8,050,400 cu.ft. for 561 clock-controlled lamps; this shows an increase on last year's figures of 7,651,500 cu.ft. and 548 lamps.

NORTH BRITISH ASSOCIATION

Flexibility and Balance in the Gas Industry

William Young Memorial Lecture

by
J. G. KING,
Ph.D., A.R.T.C., F.I.C.
(Chief Chemist, Fuel Research Station).

Presented at the Annual Meeting of the Association held at Edinburgh on Sept. 9 and 10 under the Presidency of Mr. JAMES JAMIESON (Engineer and Manager of the Edinburgh Corporation Gas Department).

I value very greatly the honour conferred upon me by the North British Association of Gas Managers in inviting me to address them in appreciation of the memory of that pioneer of the Gas Industry, William Young. I am particularly pleased in that I have a direct link with him through his colleague Sir George Beilby, whom I learned to know and admire both at the Royal Technical College and at the Fuel Research Station. In addition, I have a link with his shale interests through my association with Prof. Thomas Gray, for several years Director of Research to the Scottish Shale Industry.

The important part which William Young played in the Gas Industry of his time is well known and does not require repetition. I propose instead to adopt a theme from his life work and to elaborate this in terms of the modern problems which perplex the Industry. William Young will be remembered always as the man who first seriously considered cracking in relation to coal carbonization, but when one reads of his work one receives two main impressions. The first is his desire to research upon existing methods as exemplified by his experiments upon the absorption of hydrocarbon vapours by oil. The second is his desire to initiate new methods; having the horizontal retort he wanted something more flexible and was not satisfied until, with Samuel Glover, he had led the Industry into a variation of gas technique which has now grown immensely.

In these two impressions William Young appears both as research worker and as pioneer. What better tribute can one pay to his memory than to consider to-day what research is doing for the Industry and what developments can be visualized in the light of modern discoveries? Research in any industry must have a definite practical object and it does seem that in the Gas Industry this object should be mainly the increase of flexibility by the development of new outlets for the products of the Industry. Since the time of William Young the Industry has come to supply many new markets, but modern competition now makes it essential not only that the suitability of these products should be improved but that still other uses shall be found for them. It is only by the production of diverse products suitable for many markets that true flexibility can be achieved—that is, one which will allow of internal changes to suit the variations of markets so that plants can be maintained at full production despite seasonal or other variations and the gradual changes which occur from year to year.

In his day William Young was not content to stand still; in our day the keenness of competition makes continual advance a necessity. This can be achieved only by the immediate technical application of continued research; without application research only is futile. The type of research which leads to improvements in details of plant construction, in thermal economy, in throughput of retorts, and so on, is invaluable and is responsible for the steady progress which marks the passage of time. It is the other type which is, however, vital, the type which is characteristic of William Young, and which leads to the manufacture of new products and widens the markets which the Industry can supply.

In considering research and the application of the results of research we can therefore take as our theme the improvement of the flexibility of the Industry and the balancing of the rates of production of its many products.

It is convenient to study the modern developments in terms of the main products of the Industry, coke, gas, and tar, showing how these can be modified in properties so that the production of any one need not be limited, as it is now, by the avoidance of overproduction of any of the others.

GAS DEVELOPMENTS.

Apart from the normal steady increases of efficiency with time there are several directions in which fundamental changes in the production and application of coal gas have become indicated.

Before considering these there are two possible innovations which can be dealt with as improvements, rather than fundamental changes, but which are both of some importance. These are (i.) the further reduction of sulphur compounds in town gas and (ii.) the production of water gas from coal rather than coke.

Gas Purification.

During 1925, in a report on Gas Standards to the Board of Trade, the Fuel Research Board urged "that the more complete removal of sulphur compounds should be kept well in view" but did not recommend the imposition of a statutory limit upon the amount of organic sulphur.

Apart from the consideration that the (approx.) 300,000 million cu.ft. of gas sold annually discharges into the atmosphere 32 tons of sulphuric acid per day it must be agreed that the complete removal of organic sulphur from coal gas is a desirable achievement. It is not unlikely that the presence of sulphur in gas to-day prejudices its use in certain types of domestic appliance.

In this country the most important work in the removal of organic sulphur from coal gas has been the application of the Carpenter-Evans process by the South Metropolitan Gas Company.

The recent discovery of a satisfactory material for the removal of sulphur from water gas (B.P. 452,417 (1936)) offers a means of treating coal gas which the Industry should not neglect to investigate. The process or plant need not differ markedly from that now used for the removal of hydrogen sulphide. The process consists in passing the gas at 200°-230° C. over a contact material consisting of reactive oxides of iron containing more than 10% of alkali carbonates. It is claimed that 1 lb. of contact material will remove sulphur completely from 1,500 cu.ft. of water gas containing 13 grains of organic sulphur per 100 cu.ft. The sulphur removed remains in combination with the contact material. In an experiment at the Fuel Research Station 1,500 cu.ft. of such gas was treated per lb. and only traces of sulphur were beginning to show in the purified gas (<0·01 grain per 100 cu.ft.).

Experiments upon coal gas are now going on and show some promise. It will be necessary to determine whether the contact material will deal efficiently with all organic sulphur compounds. The contact material becomes inactive in regard to organic sulphur after it has absorbed about 5% S by weight. It can then be used for removal of hydrogen sulphide in a normal oxide box.

The thermal cost involved does not seem very formidable since the purifier boxes could be lagged and an efficient form of heat interchange adopted. An increase of temperature to 300° C. allows the contact material to take up twice as much sulphur. It is probable, however, that this temperature is, for economic reasons, rather high, to suit gas-works practice. In cases where benzole scrubbing was used it would be necessary to cool the gas between the purifier and the scrubber.

These quoted figures represent only an early stage in this investigation and can almost certainly be improved upon by further work. Experiments in the United States have already indicated contact materials allowing a very much higher space velocity for organic sulphur (W. J. Huff and L. Logan, Amer. Gas Assoc. Proc., 1936, 724). In this work the organic sulphur is converted to H_2S to be

removed subsequently. The most active catalysts were prepared from uranium oxide in admixture with copper or cerium oxide, and at 450° C. space velocities as high as 15,000 per hour were attained with almost complete conversion of organic sulphur to H_2S. The space velocity of the alkaline iron oxide is only about 200 per hour. A continuous process for the removal of all sulphur compounds also gave satisfactory results. In this case the best contact materials were found to be copper-vanadium-clay and copper-chromium-clay mixtures; either material was used at 450° C. and was revivified with air on a time cycle. It still remains, however, to be determined whether the higher space velocity compensates for the higher cost of materials. Further investigation on a practical scale would now seem to be indicated. Since gas is still the Industry's main product it is obvious that the removal of the defect of residual sulphur compounds is worthy of a real effort.

The Use of Coal in Water-Gas Plants.

The interests of flexibility in the Gas Industry could well be served under certain conditions if it were possible to replace by coal the coke normally used in water-gas manufacture. These conditions are, of course, those in which the coke market is more favourable than that for gas.

Experiments have been carried out at the Fuel Research Station in which South Wales coals of low volatile matter (17% and less) have been successfully used. The underlying principle was to vary the cycle of operations so that the coal was carbonized on the surface of the fuel bed before up-running was attempted.

A Humphreys & Glasgow "blue-gas" generator (500,000 cu.ft. per day) was used and the only modifications were:

(i.) To introduce an air supply above the fuel bed so as to burn blow-gas in the generator and heat up the upper part.

(ii.) To introduce the down-run steam into the stack so as to superheat it as much as possible.

Two methods of working which have proved satisfactory so far are:

Method A.	Method B.
(i.) Blow for 1·5 min. burning the blow gas in the generator.	(i.) Charge 4 cwt. coal with top air slightly open.
(ii.) Make producer gas 2 min. and burn in the generator.	(ii.) Open blast valve slowly to full open with 4 lb./min. of up-run steam burning gas with top air for 2 min.
(iii.) Charge 4 cwt. coal.	(iii.) Steam down for 3·5 min. with 12 lb. of steam per min.
(iv.) Supply down-steam at 2 lb./min. for 9·5 min.	(iv.) Steam "up" for 0·5 min.
(v) Steam "up" for 0·5 min. (purge).	(v.) Up and down running for 4 to 7 cycles of 4 min. each with 1 min. blows.
(vi.) Up and down-running for 4 cycles of 4 min. each with 1 min. blows.	(vi.) Up-run for 2 cycles of 4 min.
(vii.) Up-run for 2 cycles of 4 min. each to heat up the top of the fuel bed.	

Using South Wales coals of 16 to 17% volatile matter the following results have been obtained. The size of the coal was: on 2 in. screen, 1·1; 2 in. to 1 in., 48·6; 1 in. to 0·5 in., 32·7; through 0·5 in., 17·6%.

Method	A	B
Depth of fuel bed, ft.	6·5	6·5
Rate of steam supply, lb. per min.	16·0	14·0
Air pressure, in. water	20·0	20·0
Gas per ton of coal, cu.ft.	67,140	63,780
Gas per ton of coal, therms	204·8	204·1
Gas calorific value, B.Th.U.	305·0	320.0
Gas analysis—		
CO_2	4·8	3·3
C_nH_m	0·3	0·4
CO	34·9	39·5
H_2	52·9	49·7
CH_4	1·8	2·8
N_2	5·3	4·3
Output per hr., cu.ft.	12,400	14,500

Method B shows more promise than A, mainly owing to the higher output per hour of 14,500 cu.ft. An even higher output might have been attained had this coal not disintegrated in the generator and reduced the rate of gasification. In a later experiment with a *slightly*-caking coal an output of over 18,000 cu.ft. per hour was attained. Further experiment with other coals is still necessary.

During a period of 4 weeks 120 tons of coal was gasified without trouble. The 205 therms of gas produced represents a thermal efficiency of 62% and compares with the 62·5% quoted by King and Shaw for coke (Fuel Research Tech. Paper 6, 1923).

The potential yields of tar from the two coals (Gray-King assay) were 5·6 and 2·5 galls. per ton of coal. Both cycles dealt with this amount of tar efficiently, none whatever being found in the gas. Further experiments have been made with high-volatile coals but it was found impossible to crack all the tar in the generator. Alterations are now being made to the generator so as to allow of the introduction of an auxiliary cracking chamber for tar and the experiments on bituminous coal will be continued. In general it may be taken at present that coals suitable for this purpose are sized coals (doubles or trebles) having just sufficient caking power either to form a weak coke or not to disintegrate in the generator, and containing not more than 7 galls. of potential tar per ton. Further experiment should increase the range of coals which can be treated and should determine the optimum coal properties necessary for a high output of gas. Conditions may also be found for the gasification of coals of higher volatile matter. At the lower end of the scale difficulties will arise, not only as the potential tar in the coal increases, but with increase of caking power.

In the meantime it may be accepted that the replacement of coke by sized low-volatile coals, at times when the coke market is active, is a definite contribution towards the increase of flexibility in the Gas Industry. It is almost certain that further experience will remove the present difficulty of lower output. The proposal has already found favour with one London gas company and is being used in part by them. It is also of strong interest to Scotland where low-volatile coals formed by igneous intrusion are available in several districts and in considerable quantity.

Total Gasification and Gas Enrichment.

Of the more fundamental changes which appear to be imminent in the Gas Industry total gasification plays an important part. This is by no means a new process but it has not found favour in the past and its adoption now would mean a drastic change in general policy. New facts have, however, emerged during the past few years which now bring it strongly into consideration.

Three lines of development appear possible:

(i.) *Three-stage Process.*—Carbonization of coal followed by the gasification of the coke and the enrichment of the water gas by methane synthesis.

(ii.) *Two-stage Process.* The gasification of coal in a water gas plant and the enrichment of the water gas.

(iii.) *Single-stage Process.*—The gasification of coal with steam and oxygen under pressure (Lurgi process).

The two-stage process has been dealt with partly above. The three-stage process involves the development of a new technique for the enrichment of water gas to at least 450 B.Th.U. per cu.ft. The process now used is, of course, that of carburetting with gas oil, but it is indicated that an alternative process can be based upon the reaction

$$CO + 3H_2 = CH_4 + H_2O + 49{,}270 \text{ cals.}$$

The conversion of 90% of the hydrogen of water gas to methane in this way would yield a gas containing 48% of carbon monoxide and 9% of hydrogen and 27% of methane and having a calorific value of 450 B.Th.U. per cu.ft. Experiments carried out for the Colliery Owners' Research Association by D. G. Skinner and J. Ivon Graham (not yet published; quoted by permission) have shown that the reaction can readily be brought about at atmospheric pressure and at 300° C. by passing the gas over a nickel-cerium catalyst. The catalyst is supported on carbon in order, it is stated, to avoid the poisoning effect of carbon deposited as a result of side reactions.

The weakness in this process is that a nickel catalyst cannot be used with other than sulphur-free materials. If it can be shown that the process described above for the removal of organic sulphur from coal gas or water gas is a practical process, however, the enrichment of water gas in this way becomes immediately of interest.

The work of Skinner and Graham was carried out on a relatively small scale using catalyst volumes of about 820 ml., but the possible magnitude of the reaction chamber can be calculated from their data. In dealing with coal gas they reduced the carbon monoxide content of the gas from 16·4 to 4·2%, obtaining the following analyses:

—	Volume	CO_2.	C_nH_m.	CO.	H_2.	CH_4.	N_2.	B.Th.U.
Gas before	100	2·1	1·1	16·4	57·8	20·1	1·9	475
,, after	58	2·0	..	4·2	37·9	53·5	2·4	667

The calculated catalyst space necessary for the conversion of 1 million cu.ft. of gas per day is 125 cu.ft.—*i.e.*, 200 lb. of catalyst containing 60 lb. of nickel. Further experiment would almost certainly produce more compact

catalysts of greater activity and reduce not only the space required but the cost of the plant

Since the use of a nickel catalyst infers a sulphur-free gas it is interesting to record that Sebastian (Carnegie Inst. of Technology, No. 35) has shown that it may be possible to use instead of nickel a molybdenum catalyst (MoS_2) which is not poisoned by sulphur. His experiments were carried out at atmospheric pressure, and at a temperature of 450° C., using mixtures of carbon monoxide and hydrogen. Unfortunately the reaction proceeds very slowly and the size of plant necessary would be too great. Increase of rate could be achieved, however, by increasing the pressure to, say, 20 atmospheres. Investigations on these lines are being made at the Fuel Research Station, but results are not yet available. The use of a higher pressure has other advantages—(i.) it facilitates the removal of carbon dioxide from the enriched gas and (ii.) the pressure of the gas would help in the subsequent bottling if the sale of gas for transport purposes developed.

It should be remembered, however, that the enrichment of water gas in this way involves a definite thermal loss of up to 15%, since the reaction is strongly exothermic. The cost of the enriched gas must be greater than that of water gas and, in turn, greater than that of carburetted water gas at the present price of gas oil. The process is, however, sufficiently interesting to justify further exploration both in this connection and in regard to the enrichment of coal gas for use in motor vehicles (see below).

Single-Stage Processes.

The carburetted water gas process, using coal as a fuel, is largely used in the United States, a special generator—*e.g.*, Pier—and rather different technique from that of coke being used. In this country it has not yet found favour but, if satisfactory cheap coals could be used, the process would form an alternative to the two-stage process of making blue gas direct from coal and catalytic enrichment of the gas. At the present price of oil the former is the cheaper process.

A second single-stage process in that of Lurgi (Danulat, Thesis Berlin Tech. Coll., 1936; Delarozière, J. des Usines à Gaz, April 5, 1935, 157). This process involves the gasification of the coal with oxygen under pressure and is already in successful operation in Saxony, using brown coal. It is probably the most interesting process of complete gasification so far developed. Brown coal is converted in a single operation into gas of 465 B.Th.U. per cu.ft. using a gasifying medium of oxygen and superheated steam and operating at a pressure of 300 lb. per sq.in.

The methane-forming reactions (i.) and (ii.) are thermodynamically possible in the upper and cooler part of the fuel bed (800° C.).

(i.) $C + 2H_2 \rightleftharpoons CH_4$
(ii.) $CO + 3H_2 \rightleftharpoons CH_4 + H_2O$

The gas leaves the generator at a high pressure so that condensation of tar vapours, settling of dust, and scrubbing can be readily effected and in much less space. Water is used as the scrubbing liquid and removes most of the carbon dioxide and hydrogen sulphide.

—	CO_2.	H_2S.	$_nH_m$.	CO.	H_2.	CH_4.	N_2.	B.Th.U.
Crude gas . . .	31·3	1·4	0·7	14·9	34·2	14·6	2·8	320
Scrubbed gas. .	2·0	0·1	1·2	22·0	50·3	21·4	2·9	465

The amount of oxygen required is 32 cu.ft. per therm of gas made and the output of gas is 3,700 cu.ft. per hour per sq.ft. of grate area. Variation of the proportions of oxygen and steam allows of a degree of flexibility in the composition of the gas and of considerable rapidity of change of calorific value.

The size of a generator now in use in Saxony is 4 ft. diameter by 10 ft. high. Its output is 350,000 cu.ft. per day of gas at 450 B.Th.U. per cu.ft. The generator works on air-dried brown coal less than ¼ in. in particle size and uses a molecular oxygen/steam ratio of 1 to 8; 10-12 galls. of tar are recovered per ton of brown coal.

The operation of this process in Britain depends upon two things:

(i.) The suitability of English coals.
(ii.) The possibility of supplying oxygen at a sufficiently low price, say, 6d. to 12d. per 1,000 cu.ft.

The latter problem is outside the scope of this Paper, but it does seem that the reported successful production of cheap oxygen on the Continent can be repeated in this country. The process used is Fränkl's modification of Linde's liquid-air process (Gomonet, Rev. mét., 1936, 33, 560) and oxygen is now being used in quantity in the I.G. Winkler producers at Leuna and in the Ruhr blast furnaces.

Brown coal appears to be a particularly reactive fuel and it is not yet established that the process will operate so well on bituminous coal. This can be decided only by experiment, and a joint research is now being carried out by the Investigation Committee of The Institution of Gas Engineers and the Fuel Research Station. Preliminary experiments upon the course of the mechanism of the reactions are already showing promise (39th Report of the Joint Research Committee of the Inst. Gas Eng. and Leeds Univ., Part 1, 1936). At the Fuel Research Station experiments are being conducted upon a special gasification chamber for pulverized coal operating upon the vortex principle (B.P. 338,108, C. H. Lander), in which it is hoped to achieve the maximum degree of compactness.

In view of the above considerations it can therefore be said that total gasification now presents a more favourable aspect than hitherto. The position can be summed up as follows:

(i.) More experimental work is required upon catalysts for gas enrichment by the synthesis of methane.
(ii.) High-pressure gasification with cheap oxygen has the greatest potentialities for future development but it still remains to establish the suitability of British coals for the process.

Hydrocarbon Synthesis.

During recent months particular interest has been taken in the construction in Germany of large-scale plants for the production of liquid fuels by synthesis from carbon monoxide and hydrogen by the Fischer-Tropsch process.

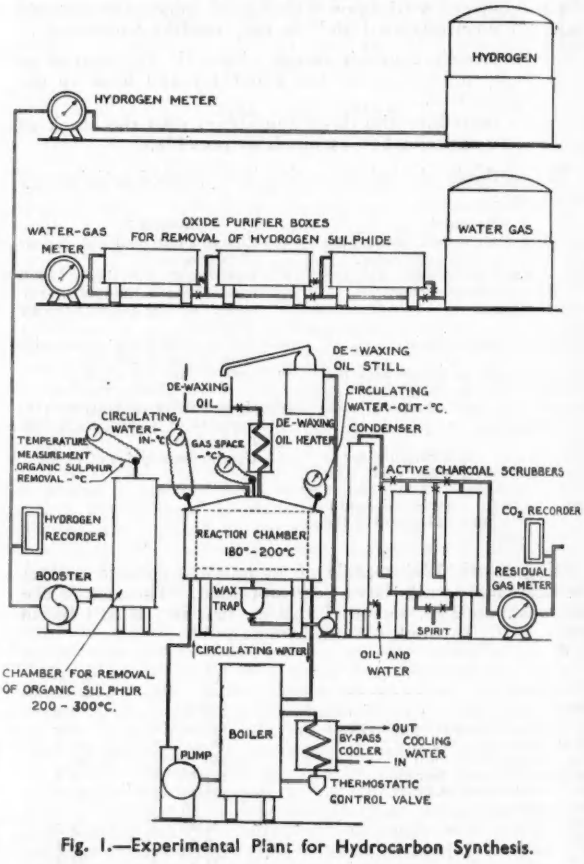


Fig. 1.—Experimental Plant for Hydrocarbon Synthesis.

It is reported that by the end of 1937 production of liquid products will be at the rate of 500,000 tons per annum.

A brief survey of the details of the process is given below (F. Fischer, J. Inst. Fuel, 1936, 10, 10; Brennstoff-Chemie, 1935, 15, 1).

Synthesis gas, consisting mainly of hydrogen and carbon monoxide in the proportions of 2 to 1 by volume, is freed from sulphur to less than 0·08 grain per 100 cu.ft. and passed through a catalyst chamber in which the temperature is maintained at from 180° to 210° C. The gas is converted into hydrocarbons covering the whole series from C_1 to C_{36}—*i.e.*, from methane to paraffin wax—together with smaller amounts of the related olefines (about 25%). The products are recovered by condensation and scrubbing of the gas.

The diagram, Fig. 1, of an experimental plant in use at the Fuel Research Station illustrates the arrangement of the necessary plant.

The greatest space-time yield of liquid products is ob-

tained by adjusting the gas supply so that a reduction of volume of 65 to 70% takes place. The residual gas contains unused carbon monoxide and hydrogen and some carbon dioxide and methane. Under these conditions a yield of liquid products of 120 Kg. (165 litres) is obtained per 1,000 m³ of "synthesis gas" treated (1·02 gall. per 1,000 cu.ft.). This product consists of:

	Wt. %.
(i.) Condensable hydrocarbons propane, butane, propylene, butylene	8
(ii.) Motor spirit, 30 to 200° C.	50
(iii.) Diesel oil, over 200° C.	39
(iv.) Paraffin wax	3

Since the reacting gases are free from sulphur these products are also free.

Fraction (i.) is available for condensation in cylinders and sale at about 10 lb. per sq.in. pressure. Fraction (ii.) is a motor spirit of suitable boiling range and stability but of rather low octane number of 55. This can be increased by the addition of lead tetraethyl (0·5 c.c./litre) to about 70. Fraction (iii.), after removal of wax, is a diesel oil of very high cetene number (95 to 100) which is valuable as a blending stock. A 50:50 mixture with creosote is suitable for the high-speed diesel engine so that, were this synthetic diesel oil available in the Gas Industry it would render an equal amount of creosote saleable in this at present profitable, if limited, market.

The proportion of these fractions can be varied in that the higher-boiling fractions can be cracked to give motor spirit only. Also, the fractions containing olefines can be polymerized with aluminium chloride or by chlorination followed by treatment with metallic aluminium to give lubricating oils. The best oil is stated to be made from fraction 150° to 200° C.

Given a satisfactory catalyst, the operation of the hydrocarbon synthesis has three critical features:

(i.) The production of synthesis gas.
(ii.) The freeing of this gas from sulphur compounds.
(iii.) The careful control of the exothermic heat of reaction so that the best temperature can be maintained for the production of liquid products.

The preparation of the synthesis gas is directly apposite to the Gas Industry. One method is by the manufacture of blue water gas from coke, passing coal gas through the fuel bed during the run to raise the proportion of hydrogen to carbon monoxide. Generally speaking, three times the quantity of coal gas that would be produced in the preparation of coke for the water-gas process is required. Where the additional coal gas is not available it is necessary to oxidize, with steam, part of the carbon monoxide to dioxide and remove this by washing with water. The purification of the gas from sulphur has already been dealt with; the method suggested is also not foreign to gas practice. As regards temperature control, one method is to construct the reaction chamber in the form of a nest of tubes spaced, say, 1 cm. apart. The pelleted catalyst is arranged in the spaces between the tubes and through the tubes is circulated water from a boiler in which the pressure can be controlled to within, say, 1 lb. per sq.in. pressure. Since the working temperature is about 190° C. and corresponds to a pressure of 152 lb. per sq.in. the possible variation of temperature in the circulating water is reduced to ± 0·2° C.

If the necessary plant is considered as a whole it will be seen therefore that at least part of the technique is already familiar to the Gas Industry and that the remainder does not present difficulties which could not be readily overcome by the gas engineer.

It is calculated by the Ruhrchemie A.G. (Koppers Review, Vol. 2, No. 3, 1937) that a commercial plant of the minimum economic size is one capable of producing 25,000 tons of liquid product per annum and consisting of 25 unit converters. Since 5 tons of coke are required to produce one ton of mixed liquid products the total coke required would be 125,000 tons—*i.e.*, more than the total available for sale in a town of the size of Edinburgh.

Given the necessary quantity of coke the dimensions of a plant can be visualized from the following essential requirements:

(i.) Water gas plant for production of synthesis gas.
(ii.) Purification plant for organic sulphur (see above).
(iii.) Catalyst chamber; one volume of catalyst will treat 75 volumes of gas per hour and the volume of the catalyst chamber is approximately 50% greater than that of the catalyst.
(iv.) Condensing plant to handle 30 to 35% of the synthesis gas at 200° C. Heat interchange would be essential.
(v.) Plant for the manufacture of catalyst.

It will be realized that the first four do not present insuperable difficulties. Experiments at the Fuel Research Station have shown that the preparation of a satisfactory cobalt-thorium catalyst is a relatively simple matter.

The preparation of the products for the market presents more difficulty since a market would have to be developed for bottled gas and a cracking process would be required to raise the octane number of the motor spirit and dispose of the surplus wax.

It may be said in conclusion that the process as a whole does commend itself to the Gas Industry. Also, despite the economic limit at present assessed for commercial plant it would seem that unit converters of 1,000 m³ per day capacity would be worthy of trial at different points. Four such units would require 20,000 tons of coke per annum and 360 million cu.ft. of coal gas and would produce 4,000 tons of liquid products per annum. Such quantities are within the reach of many of the bigger gas undertakings of this country. Alternatively, it should be possible by centralizing the plant to provide from a number of towns the coke necessary for a plant of the larger size.

High-Pressure Gas for Road Transport.

A good deal of pioneer work has already been done in this country in respect of the use of compressed coal gas in road vehicles. As a fuel for the internal combustion engine gas compares favourably with petrol in giving a higher efficiency, more flexibility, and better acceleration, and a similar power output. Crank-case dilution is also avoided. It possesses the fundamental drawback that the gas must be carried in strong storage vessels whose weight adds to the load carried and limits the effective range of the vehicle. Development work by the Chesterfield Tube Company and by Messrs. Vickers-Armstrong has led to the production of Ni-Cr-Mo steel cylinders which combine high tensile strength with a high resistance to shock and vibration. Solid-drawn, weldless cylinders are now being made in different sizes, but that most suitable for heavy lorries has a capacity of 1·76 cu.ft. at atmospheric pressure or 350 cu.ft. at 3,000 lb. per sq.in. Their outside diameter is 7·9 in., wall thickness 0·205 in., and length 6 ft. 2 in.; they weigh 110 lb. empty and 124 lb. charged.

It has been calculated that this quantity of gas at 480 B.Th.U. is equivalent to 1·32 galls. of petrol or 0·7 gall. of heavy oil. Lorries or 'buses could carry enough gas for a 60-75 mile journey as compared with 100 miles for petrol or 200 miles for oil.

The potential field for the use of gas in this way in Great Britain is large. Assuming at the moment that gas is not suitable for the private car and that heavy vehicles consume half of the total petrol then we have a potential market for the gas equivalent to 650 million galls. of petrol per annum. Even if the Gas Industry could take one-tenth of this load the quantity of gas concerned would be over 17,000 million cu.ft. This represents 5 to 6% of the gas now made and would mean a remarkable advance in gas production.

In order to utilize coal gas in this way, however, a suitable chain of filling stations would be necessary before the conversion of vehicles to gas could be considered. Such stations would require fairly expensive equipment such as high-capacity pumps and high-pressure storage vessels. Storage cylinders, for use at a pressure of 5,000 lb. per sq.in. are already available, whose properties and period of use are controlled by Home Office Regulations (1933). The filling from the tanks of cylinders carried by vehicles is a relatively easy matter, over-filling being prevented by an automatic stop-valve. In the vehicle itself the cylinders are carried in a suitable frame conveniently arranged, say, below the chassis. The gas is delivered to the engine through a two-stage reducing valve, a gas-air mixer instead of a carburettor, and a flame-arrester safety device.

Altogether, the arrangements and apparatus necessary for using gas have been the subject of extensive trial and are either satisfactory now or can readily be made so. It remains therefore to consider the economics of the proposal in order to discover what chance gas has of replacing petrol on the roads. In considering costs it is necessary to take into account:

(i.) The initial cost of the gas.
(ii.) The cost of compression and storage.
(iii.) The cost of vehicle conversion.
(iv.) The possible increase of taxation charges due to the heavy weight of cylinders carried.

These costs can be considered in terms of the equivalent cost per gallon of petrol replaced, taking 265 cu.ft. of gas at 480 B.Th.U. as equivalent to one gallon of petrol. Such costs have been calculated by R. Cook, of the Fuel Research Station (J. Inst. Fuel, 1936, 9, 125). Taking coal gas at 4d. per therm or 5·22d. per equivalent gallon, he assesses compression and storage charges at 4·26d. In

comparing vehicle performance, Cook deduces that heavy oil, not petrol, is the real competitor of gas, quoting comparison figures for an omnibus service of 7·78d. for oil and 9·14d. for gas, per equivalent gallon of petrol.

It is possible, however, that the cost of gas is appreciably higher than that stated by Cook, the difference being caused by heavier charges for stand-by plant at filling stations. Later figures for cost have been quoted at 16d. to 20d. per equivalent gallon.

At present, therefore, this possible market for gas is awaiting further advances in knowledge for its consummation. There are, however, two lines of development which may provide a solution for the future. These are (i.) the enrichment of coal gas or the use of rich gases and (ii.) the design of a special gas engine for this particular purpose.

In the case of rich gases the cost of compression would be reduced, and operating radius increased, in proportion to calorific value. One source of rich gas lies in the low-temperature carbonization of cannel or bituminous coal. A more promising source of "high-grade" gas is the synthesis process referred to above for gas enrichment. Should this process develop at a reasonable cost it might well bring compressed gas to a cost basis comparable with oil.

The design of a special engine for gas is necessary because the thermal efficiency of the petrol engine on gas is low when the vehicle is operating on a low load factor. A special design would decrease fuel costs and increase the radius of action. The new engine would have a higher compression ratio (+ 1·2 ratios) to compensate for its lower power output on gas (90%). The thermal efficiency of the petrol engine is already 20-30% higher on gas than on petrol.

To summarize the position, it would appear that the use of gas in compressed form is a reasonable proposition in competition with petrol but not with heavy oil. Further development would still require the following:

(i.) A Government undertaking regarding the continuance of the road-fuel tax in favour of gas.
(ii.) An allowance in respect of the heavy-vehicle licencing tax for the extra weight of cylinders carried.
(iii.) A continued research on methane synthesis or gas enrichment to provide a high-grade gas.
(iv.) A new engine.

Given these possibilities the market for town gas could be increased considerably by the replacement of even a small proportion of the motor spirit now used on heavy vehicles.

COKE DEVELOPMENTS.

During 1934, 7·50 million tons of coke were sold by gas undertakings. Of this quantity 0·8 million ton were exported and the remaining 6·7 million tons were consumed in home markets. Since it would be essential to develop coke markets equally with those for gas if a proper balance of production is to be maintained it is interesting to consider what happens to this coke. W. L. Boon (Publication 114, Institution of Gas Engineers, 1935) has examined the London market for 1934 (2·7 million tons), and makes the following distribution:

	%
Domestic boilers	47
Central heating	35
Industrial	14
Open fires	4

If it is considered that this distribution is typical of the whole country it becomes apparent that gas coke has only a very small share in the large market (about 27 million tons) for fuel which the domestic open fire provides. Surely the Gas Industry can, with the facilities at its disposal, provide such fuels as can replace a much larger proportion of the coal now burned in domestic grates. At present the provision of special grates is giving a small outlet for normal, unreactive, gas coke, but it would seem that a much greater share could be claimed if only gas cokes could be supplied which would ignite as readily and would burn as well as low-temperature smokeless fuels in the type of grate being provided by most building contractors. The available market is actually larger than the total gas coke now sold to-day and there is no real reason why the Gas Industry should not become equally a *solid fuel* industry, the balance of production being preserved by the adjustment of gas production as suggested above.

The problem of the production of more reactive cokes has so far been attacked by studying the effect of the following; other methods would no doubt emerge if a real attack were made.

(i.) The blending of coals of different type.
(ii) The addition to coal before carbonization of combustion catalysts.
(iii.) The carbonization in continuous vertical retorts of sized coals of a suitable type.

The Blending of Dissimilar Coals.

The possibilities of blending can best be illustrated by quoting from experiments which have been in progress at the Fuel Research Station for some years. In this programme of work it was intended to assess the effect of carbonizing mixtures of one caking coal with a series of non-caking coals and *vice versa*. So far, one non-caking coal (Warwickshire) has been examined in blends with two dissimilar caking coals (Durham and South Wales). The results have followed the same general lines so that the Durham results only need be taken for the moment.

Experiments in the first place at normal gas retort temperatures showed that there was an optimum proportion of the two coals at which a minimum amount of breeze was formed and at which the strength of the coke reached an optimum (high) value. The results of the strength tests for all cokes from 100 to 0% of the caking coal are shown

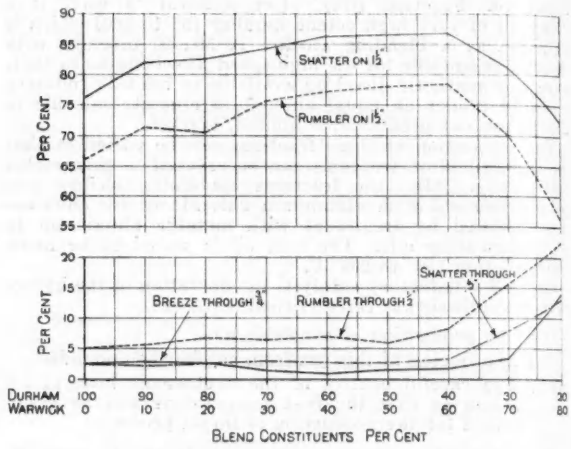


Fig. 2.—Physical Tests on Cokes from Blends.

in Fig. 2. A sharp decrease of strength in the coke is shown as the percentage of Durham coal falls below 40, but between 40 and 60% the coke is uniformly good. A sharp increase in the amount of breeze formed also appears below 40% caking coal. We have, therefore, in blending, a means whereby the strength of gas cokes can be improved by the addition of a type of coal which is normally cheaper than gas coal.

The proportion which can be added depends upon the caking power of the coal used. In Scotland, where coals of the Durham type are not available, the proportion of caking coal must be higher.

In these high-temperature experiments the volatile matter in the cokes was reduced to 1-2%, so that they were not readily combustible in the open grate. The optimum-blend coke was, however, more reactive than the straight Durham coke, as shown by the values in Table 1.

TABLE I.

Coal.	Reactivity Value. I.	III.
Durham	126	59
Blend: Durham 40/Warwickshire 60	145	102
Warwickshire	110	109

The high value for R.III of 102 is much above the average for gas cokes.

The production of blend cokes in this way is associated with a normal gas yield of about 75 therms per ton of coal. Similar Fuel Research experiments (J. F. Shaw and J. G. King, Publ. 88/3, 1934, Inst. Gas Eng.) at a lower temperature of carbonization have shown that, at a sacrifice of gas yield, a coke sufficiently reactive for the open grate can be prepared in a chamber oven. A further improvement can be obtained by replacing part of the non-caking coal by coke breeze. This addition is limited, however, to about 5 to 8%, since a greater addition reduces the strength of the coke unduly. The effect of the reduced temperature upon gas yields is shown in Table 2.

The data in Table 2 show that working at the lower temperature involves a sacrifice of gas yield of 22·3 and 23·8 therms per ton respectively in experiments 2 and 3. The loss of output is even greater during the longer time of

TABLE 2.—*Gas Yields from Chamber Oven Blends.*

—	1	2	3
Temperature of carbonization, ° C.	1,350–920	850–650	850–650
Coal, %—			
Durham	60	60	60
Warwickshire	40	40	30
Coke breeze	..	..	10
Time of carbonization, hrs.	13·5	20	20
Gas per ton, cu.ft.	14,420	6,650	5,800
,, ,, , therms	75·8	43·5	42·0
Gas per retort per day, therms	341·5	117·5	113·5
Volatile matter in coke, %	0·8	7·2	6·0

carbonization at the lower temperature. This sacrifice of gas yield is offset by the increased combustibility of the cokes. The strength of the coke is not reduced since the 1½ in. shatter and rumbler indices shown in Table 3 compare quite favourably with those of the high-temperature cokes shown in Fig. 2.

TABLE 3.—*Shatter and Rumbler Indices.*

Durham coal	60	60
Warwickshire coal	40	30
Coke breeze	..	10
Shatter index—		
Over 1½ in.	83·0	82 0
Under ½ in.	6·4	10·0
Abrasion index—		
Over 1½ in.	72·5	67·4
Under ½ in.	12·8	23·8

The superior combustibility of the cokes is shown by the radiation curve (3) in Fig. 3, in which the rate of radiation from an open fire is compared with a low-temperature coke standard. The comparison is only a little in favour of the latter. We have, therefore, in this variation of the process of gas manufacture a means of increasing the domestic market for gas coke which the Industry should explore. Should such an increase tend to upset the balance between coke and gas sales it would be offset by the lower gas yield realized. The radiation curves are obtained by a standardized method evolved at the Fuel Research Station in which a standard bulk of fuel is burned in an open grate. The data collected are shown in Table 4 for the cokes discussed above and also for others which are discussed later in the Paper.

matter, will burn pleasantly, and sufficiently rapidly, in an open grate. Since the ignition temperature of coke is reduced in the presence of sodium salts it is also probable that treated coke would be sufficiently readily ignitable for ordinary purposes.

A horizontal retort coke, made with the addition of alkalis equivalent to 0·7% Na_2O gave in the open grate the radiation curve (6) shown in Fig. 3 and the data shown in Table 4. Although the initial rate of burning up was rather slow the coke could be said to be almost satisfactory for a well-type grate and quite suitable for a barred grate.

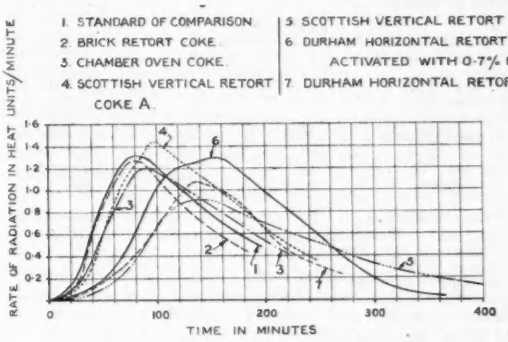


Fig. 3.—Radiation Curves of Domestic Fuels.

It has been stated (23rd Report of the Joint Research Committee of The Institution of Gas Engineers and Leeds University, Studies in Carbonization, Part V.) that the yield of gas is increased by the addition of alkalis. In the carbonization at 920° C. of (i.) Durham and (ii.) Nottinghamshire coals the following increases were obtained by the addition of 2% of sodium carbonate.

—	(i.).		(ii.).	
	Cu.Ft./Ton.	Therms.	Cu.Ft./Ton.	Therms.
Without Na_2CO_3	12,007	71·7	11,880	70·4
With Na_2CO_3	12,750	72·3	14,200	76·1

The gain in (ii.) is very marked.

TABLE 4.—*Combustibility Curves of Reactive Gas Cokes.*

Coke	(i.)	(ii.)	(iii.)	(iv.)	(v.)	(vi.)	(vii.)
Heat for ignition, B.Th.U.	1,120	1,070	1,900	1,010	3,900	2,910	3,080
Time for intense fire, min.	56	53	73	66	..	100	122
Max. radiation, units	1·32	1·26	1·10	1·43	0·92	1·32	1·08
Coke consumed, %	76	71	63	78	86	69	51
Bulk density, lb./cu.ft.	20·6	17·7	29·0	20·8	25·0	24·6	25·2
Volatile matter, %	6·8	7·5	6·0	4·0	1·6	0·8	0·8

(i.) Standard Fuel Research Station low-temperature coke.
(ii.) Low-temperature coke from F.R "Brick Retorts" at 700° C.
(iii.) Chamber oven coke, medium temperature, 650°–850° C.
(iv) Scottish vertical retort coke A, medium temperature.
(v.) Scottish vertical retort coke B, normal temperature.
(vi.) Alkali-activated Durham horizontal retort coke (0·7% Na_2O in the coke).
(vii.) Durham horizontal retort coke, not activated.

The Addition of Combustion Catalysts.

A different method of increasing reactivity in gas coke, which does not postulate changes in technique, is by the impregnation of the coal before carbonization with a substance which catalyses the combustion of the resulting coke at a temperature lower than normal. The first substance suggested for this purpose was iron oxide (Imray, 1924) but more marked changes have been shown by Cobb and his co-workers (Gas Research Fellowship Reports, 1926, '27, '29) to be possible by the use of sodium carbonate or mixtures of this substance with lime; cokes prepared with 5% sodium carbonate showed a steam decomposition rate of 98% as against a rate of only 61% for straight coke from the same coal.

It has recently been suggested that a less amount of sodium carbonate is necessary to impart reactivity if a proportion of calcium oxide is also added. Progress reports of the Midland Coke Research Committee have shown that the addition to a low-ash coal of 0·5 to 0·75% of CaO and the same amount of sodium carbonate will give cokes which, if slightly undercarbonized to leave 2-3% of volatile

Sufficient seems to have been done, therefore, to show that coke for the ordinary open grate could be made in this way. Before the preparation of such coke can be attempted on a large scale it will be necessary to make certain whether or not the addition of alkalis to coal will reduce the life of retorts either directly or by the carriage of fusible dust from the producer into the combustion chambers.

The Selection of Special Coals.

It has long been realized that the cokes of non-caking or weakly-caking coals are not only more readily ignitable but are more readily combustible than cokes prepared under the same conditions of high-temperature carbonization from coking coals. Full use has not, however, been made of this difference, and an attempt is now being made by Mr. Jamieson, of the Edinburgh Gas Department, and myself to demonstrate how this effect can be put to practical use, particularly in Scotland.

The object of the experiments at Edinburgh is to show that combustible cokes can be prepared by carbonizing in

continuous vertical gas retorts sized weakly-caking coals. We have already established that a suitable size is a mixture of doubles and trebles, that the agglutinating value of the coal should be in the region of 8 to 10 (B.S.S. 705), and that the ash should preferably not be white or light-coloured. In order to make the coke readily ignitable the temperature of carbonization has been reduced so as to leave from 4 to 6% of volatile matter in the coke. This percentage was arrived at by testing a series of cokes. In one experiment, in which the carbonizing temperature was reduced to 1,200° C. (top) and 940° C. (bottom), the following results were obtained using an Ayrshire coal having the desired properties:

TABLE 5.

Coal—	
Moisture, %	8·0
Volatile matter, %	37·1
Ash, %	3·7
Per retort per day, tons	11·22
Steam %	18·6
Temperature top, °C.	1,200
,, bottom, °C.	940
Gas—	
Yield per ton of coal, cu.ft.	10,700
,, ,, ,, therms	58·5
Yield per retort per day, therms	656
B.Th.U. per cu.ft.	546
Tar (dry) per ton of coal, galls.	18·2
Coke (dry)—	
Yield per ton of coal, cwt.	11·6
Volatile matter, %	4·0
Benzole—	
Yield per ton, galls.	2·5
Sp.gr. at 15° C.	0·815

The coal, as charged to the retort, was a mixture of equal parts of doubles and trebles. Its caking power was such that some agglomeration took place and very little breakdown. This is shown by the following size-analyses:

Size.	On 2 In.	2–1½ In.	1½–1 In.	1–¾ In.	¾–0 In.
Coal	0·5	6·5	46·3	27·4	19·3
Coke	11·3	19·3	32·5	15·7	21·2

The combustibility tests of the coke were made by the Fuel Research radiation method and the results are included in Table 4 and the radiation curve in Fig. 3, curve 4. The coke was entirely satisfactory and compares favourably with the coke made by carbonizing similar coal under normal gas-making conditions (Fig. 3, curve 5).

The careful choice of coal and its treatment under these conditions offers, therefore, a further means of increasing the market for gas coke. Since the yield of gas from this type of coal is 70 therms at 480 B.Th.U. under normal conditions the manufacture of the special fuel implies a sacrifice of gas yield of 16% but a rather richer gas. The extra price obtainable for the coke should more than compensate for this and the balance of gas and coke production would not be disturbed to as great an extent as if the full yield of gas were realized.

Cannel.

Cannels may also be considered under the heading of special coal. The particular importance of cannels lies, however, not so much in their immediate value as in the potential source of oil which they represent. It is a difficult matter to estimate the amount, available in this country, of cannel of sufficiently high grade since the cannel occurs only in variable bands in coal seams. It has, however, been estimated by the Scottish Development Committee (Second Report of Oil from Coal Committee) that there are reserves in Scotland of over 25 million tons of the highest quality cannel, capable of yielding over 40 galls. of tar per ton.

J. Jamieson and J. G. King (Publication 135/34 Inst. Gas E., 1936) have shown how the flexibility of gas manufacture can be increased by replacing part of the coal by cannel. The scope of such replacement is limited, of course, to those undertakings to which supplies of cannel are available at a reasonable cost.

In the above experimental work Newbattle cannel was carbonized in continuous vertical gas retorts at Edinburgh and the following results were obtained (Test F):

Cannel per retort per day, tons	8·8
Gas per ton of cannel, cu.ft.	25,000
,, ,, ,, ,, therms	120
Gas, B.Th.U. per cu.ft.	480
Gas per retort per day, therms	1,050
Tar (dry) per ton of cannel, galls.	40 to 50
Coke (dry) ,, ,, ,, cwt.	7·2
Gas spirit ,, ,, ,, galls.	4·1

The cannel was charged in lump form and gave a strong coke of sufficiently good grading for sale. At a volatile matter content of about 4% (dry, ash-free) it was suitable for sale as an open-grate fuel. As a gas-making coal the yield was very satisfactory at 120 therms per ton of 480 B.Th.U. gas. The tar, moreover, was of special interest in providing a potential source of motor spirit and diesel oil. Experiments at the Fuel Research Station have shown that this tar, even at this high temperature of carbonization, is amenable to vapour-phase hydrogenation. From 100 galls. of the tar can be produced

either 105 galls. motor spirit and 57 lb. paraffin wax	*or* 36 galls. spirit 67 galls. diesel oil 57 lb. paraffin wax

the expenditure of hydrogen in the first case being 140 cu.ft. The motor spirit had the rather low octane number of 60 but the diesel oil (cetene number 40) was more promising. Even at the normal far price of 2d. per gallon it was possible to make gas from cannel at Edinburgh at 1·27d. per therm as against 1·33d. from bituminous coal. The properties of cannel tar are such, however, that it should achieve a much better price; at 4d. per gallon the cost of gas would become 0·5d. per therm. The full value of this potential source of oil cannot, of course, be realized without access to a hydrogenation process of the type dealt with later under tar. When new outlets become available cannel must become of particular importance to conveniently situated gas undertakings. In particular, further research on cracking is definitely indicated.

As a general conclusion to these recommendations to make better use of coals having special properties, a suggestion can be made that there should be closer co-operation between the coal and gas industries so that the latter may make full use of the coals available.

Active Carbon.

Experiments at the Fuel Research Station have shown that it is possible to produce active carbon from certain selected Scottish coals by processes familiar to the gas engineer. The particular object of this investigation was the production of carbon direct from sized coals and without briquetting. This was successfully attained, the special features of the process (J. G. King, B.P. Appl. 11,889, 1936) were:

(i.) The careful choice of coal.
(ii.) The carbonization of this coal in a sized form at a temperature preferably below 500° C.
(iii.) The activation of the coke with steam at 950° C. under controlled conditions.
(iv.) The crushing and grading of the activated coke in such a manner as to avoid undue loss.

The most suitable coal for the purpose was found to be the dull, hard coal or durain which occurs in bands in bituminous seams and is readily separable by handpicking. Such coals are rich in plant remains and if they possess the correct caking power give on carbonization a coke which retains the original porosity of the coal, increased by the formation of cavities from which the plant remains have been liquated. Should a secondary cell structure develop in a coal by fusion and intumescence during carbonization the resulting coke cannot be activated. The choice of coal is therefore strictly limited, but it is also true that there are available in the country plentiful supplies of coal of the right type. In Scotland very suitable durains or hards were found in the Kelty Main and Diamond seams of the Fife Coal Company.

Carbonization of such coals at temperatures as low as 500° C. is not perhaps a common practice in the Gas Industry but does not present insuperable difficulties. The final stage of steam treatment is merely an extension of vertical retort practice. The temperature necessary (in the charge) is 950° C. or more, and sufficient steam is required to gasify about 70% of the coke. In a fairly gas-tight retort this could be done by introducing superheated steam equal to 150% of the weight of the coke charged.

If an activating retort were being built for the purpose it would certainly differ from a modern vertical gas retort in that regeneration would be adopted to raise the steam temperature to as near 950° C. as possible and thereby decrease the thickness of the reaction zone. Indeed, a chamber can be visualized with horizontal gas flow across a descending stream of coke, the direction of flow of steam entering and gas leaving being alternated on a time cycle through side generators. It is nevertheless true that a modern gas retort is quite suitable for the process provided the steam can be superheated to over 500° C. At the Fuel Research Station satisfactory results were obtained with a "narrow brick" retort, the input of coke being 1·5 tons per retort per day.

It would seem, therefore, that the Fuel Research experiments should be extended to the full scale to determine

which existing gas plant can best prepare this type of carbon. So far as immediate requirements are concerned production of active carbon has possibilities which touch the Gas Industry closely. It seems certain that continued research would lead to the production of carbons suitable for such purposes as solvent and benzole recovery, decolorization, and deodorization. The first of these affects the Gas Industry closely since the carbon could be used in place of oil for gas scrubbing, and the possibility of employing British coals for the manufacture of all carbon to replace imported carbon and petroleum wash-oils is an attractive one.

The Beckton plant (H. Hollings and S. Hay, J.S.C.I., 1934, 53, 143) has a capacity of 4·5 million galls. and in 1935 produced 3 million galls. at the rate of 3·10 galls./ton of coal. The total recovery in the Gas Industry was 8½ million galls.

During 1935 the benzole was recovered in the Gas Industry from 44·4% of the coal carbonized and has since increased to 50% in 1936. The average yield in 1935 was 2·16 galls. per ton.

The use of carbons for the treatment of effluents is also of direct interest to the Industry.

Although the total output of carbon could not be large, the price available for good carbons is high and the flexibility of the Industry would benefit by the operation of retorts for the manufacture of carbon during slack periods.

A still further interest lies in the possible preparation of carbons of a less degree of activity. The relatively high combustibility of " steamed " vertical retort coke makes it more valuable in certain circumstances than horizontal retort or oven coke. This has already been extended by certain gas undertakings who are steaming particularly heavily in order to produce smokeless fuels suitable for the open grate. It now would seem possible to extend vertical retort technique by (*a*) careful choice of graded coals and (*b*) by controlled steaming to produce a variety of cokes of different degrees of combustibility. Increase of combustibility implies much less drastic steaming of the coke than is necessary in imparting sufficient activity for gas or vapour adsorption and the loss of coke yield should not be so high. One new market for reactive coke is the motor-lorry gas producer. Low-temperature coke has already been shown to be a satisfactory fuel for these producers, although in some types the small amount of tar still in the coke (several ounces per ton) is sufficient to give trouble with sticking of inlet valves. A reactive coke made by steaming low-temperature coke at a high temperature would be even more reactive than the original low-temperature coke and could be made to contain no tar vapour whatever on gasification. The possibilities of the motor-lorry producer are dealt with below.

Reactive Coke for Motor Lorry Producers.

We have already discussed the possibility of producing, during the normal process of gas making, a coke which is more reactive than formerly. Although the market which is always considered first for such cokes is the domestic market there is another which has a prominent place in considerations of home-produced fuels. This is the suction-gas producer for commercial motor vehicles.

Experimental work in this country dates back to before 1917 when the War Office tried out the Smith producer. Since then a great deal of exploration work has been done and successful producer designs are in operation in France and in the Dominions, working mainly on charcoal. In this country charcoal could not be available in sufficient quantity for development work to be based upon its supply in quantity. The obvious alternatives, anthracite and coke, have disadvantages, the first in regard to friability and tar vapour and the second with regard to lack of combustibility. The use of anthracite is outside the scope of this Paper, but the modification of coke, or the production of active cokes, is definitely of interest to the Gas Industry.

Experiments have been conducted with low-temperature carbonization cokes, but only with partial success, since these fuels are normally high in volatile matter and give some tar on gasification which gives trouble in the engine. The ideal fuel would seem to be a reactive coke which would have the characteristics of—

(i.) High reactivity to give a low fuel-bed temperature and a high CO/CO_2 ratio.

(ii.) No tar vapour on gasification.

(iii.) Close grading, say, 1 in. to ½ in. size.

(iv.) A type of ash which would give no clinker troubles.

Characteristics (iii.) and (iv.) present no real difficulties and it remains to discover whether the Gas Industry could manufacture, without undue cost, a reactive coke of sufficiently low volatile matter free from potential tar, to satisfy requirements. The production of such cokes has already been dealt with and it is considered that those described above could supply this market.

(i.) Coke made by the carbonization, in continuous-vertical retorts at a carbonizing temperature of 1,200°-900° C., of special coals (*e.g.*, Scottish).

(ii.) Coke activated by the addition before carbonization of alkalis.

(iii.) Specially reactive coke made by low-temperature carbonization and high steaming.

The general considerations in regard to suction-gas vehicles are as follows: The extra weight of apparatus to be carried is about 5 cwt. per vehicle, but convenient arrangement may avoid any real loss of space. The fuel, however, does represent loss of load-carrying capacity, depending upon the radius of action. Time is taken up in getting the producer under way from cold; this may be estimated at 5 to 10 minutes. It is also rather difficult to control the proportion of water to air entering the producer and to make adjustments in general for different conditions of running.

Despite these drawbacks it seems more than possible that an impetus could be given to the design and supply of producer-gas driven vehicles if the Gas Industry were able to supply at many points throughout the country suitable graded fuels. The proportional replacement of motor spirit can be calculated from the following experimental results: Russell (World Pet. Congr., 1933) quotes for the 94 mile journey of a 3-ton truck 102 lb. of charcoal in comparison with 7 galls. petrol—*i.e.*, charcoal 0·36 lb. and petrol 0·025 gall. per ton per mile. Comparison in terms of brake horsepower give 1 lb. of carbon, 0·5 lb. of petrol, and 0·4 lb. diesel oil per B.H.P. per hour. As regards radius of action it has been claimed that a motor 'bus will travel 240 miles on one load of 3 cwt. of carbon, the fuel being carried at a sacrifice of 2 seats out of 34. Servicing of the gas-cleaning plant is desirable every 24 hours.

It can be estimated that for every million gallons of petrol replaced 7,000 tons of reactive coke would be required, or alternatively that one million tons of reactive coke, an increase of coke production of about 12%, would replace 140 million galls. of petrol—*i.e.*, 10% of the 1936 consumption in Great Britain.

TAR DEVELOPMENTS.

The only development in tar treatment which is of real importance to the Industry is that of hydrogenation-cracking. The markets for tar have always been variable, and, although road tar, absorbing 850,000 tons out of 1·8 million tons made, has helped very considerably there have been periods when creosote and pitch have been saleable only at very low prices. Recently, however, creosote has been finding a ready market at a good price. This does not, however, help the pitch position, and since the process is outside the control of the Gas Industry it is open to question whether the position is really satisfactory to that Industry.

The alternative would be for the Industry or an associated body to undertake hydrogenation-cracking in a suitable central position. The technical position regarding the treatment of tar was discussed in 1932 by J. G. King and M. A. Matthews (J. Inst. Fuel, 1932, 6, 733), and the situation has changed since then only to the extent that more is known of the behaviour of the vapour-phase catalyst, and some results have been obtained of the liquid-phase hydrogenation of vertical-gas-retort tar. It has been shown that low-temperature tar can be treated in one (vapour) phase to give a satisfactory yield of high-quality motor spirit so that the present position of tar hydrogenation can be illustrated with reference to low-temperature tar and tar distillates. Researches at the Fuel Research Station have shown (J. G. King and J. F. Shaw, World Power Conference, 1936, Paper G.4) that the reactions take the same general course whether the scale of treatment is 12 ml. per hour or 40 litres—*i.e.*, 3,300 times. They have also demonstrated a cycle of operations for the larger plant, which is the same as that which would be used on a manufacturing scale.

This cycle of operations is indicated in the diagram Fig. 4.

Tar and recycle oil are pumped with hydrogen at 200 atmos. pressure through a heat-interchanger, in which heat is withdrawn from the hot products leaving the converter, then through a gas-fired preheater into the top of the converter. The tar and hydrogen flow downwards through the converter, the products leave by a dip pipe and are collected in a high-pressure separator where permanent gas is separated, scrubbed with wash oil to remove hydrocarbons and the recovered hydrogen recirculated. The oil product is distilled to give motor spirit and recycle oil.

The reactions of hydrogenation-cracking are strongly

exothermic and sufficient heat is generated to carry on the process at 480° to 500° C. provided the tar and hydrogen entering the system is preheated to about 400° C.

The thermal quantities involved in the treatment of tar at the rate of 17 galls. per hour, with 6,000 cu.ft. of hydrogen, were:

Given to raw materials in preheater (32,440 B.Th.U./hr.)	100
Heat of reaction	188
	288
Sensible heat loss from converter	101
,, ,, ,, heater-exchanger	44
,, ,, ,, connections	10
,, ,, in condenser	133
	288

It is not possible here to describe so complicated a technique in detail, but this is not necessary, since all that concerns the Gas Industry at present are the two main questions (i.) whether the products are satisfactory, and (ii.) whether it would be desirable for the Industry to venture into a field which would involve all the difficulties and demand all the specialized knowledge of high-pressure work.

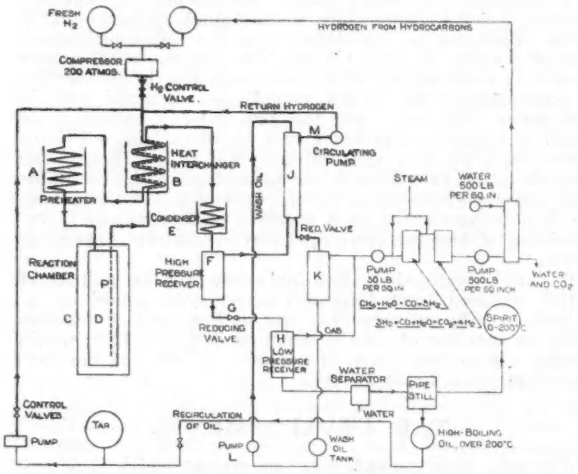


Fig. 4.—Diagram of Experimental Plant for the Hydrogenation of Tars.

The first is almost completely answered by the work of the Fuel Research Station. With regard to the second, it can be accepted that costs would be prohibitive unless the scale used were very large. However, since coal hydrogenation has proved successful despite a more complicated technique, the outlook for tar, given the necessary quantity, would seem sufficiently bright. Certain parts of the process, such as the production of hydrogen from spent rich gas by cracking with steam, are more comparable with modern gas manufacturing processes and would present comparatively slight difficulty.

The quantities at present concerned in the hydrogenation-cracking of low-temperature tar are given in Table 6, together with the properties of the spirits. The yield of spirit in one treatment is higher for creosote than for low-temperature tar; distillates from the tar, however, give even better results than creosote.

TABLE 6.—*Hydrogenation of Low-Temperature Tar and Spirit.*

VOLUME YIELDS AND PROPERTIES OF SPIRIT.

Raw Material	Low-temp. Tar.	Creosote.
One treatment—		
Spirit to 200° C., %	55	72
Oil over 200° C., ,,	53	41
H_2 absorbed per gall., cu.ft.	100	120.
Complete conversion to spirit—		
Spirit to 200° C., %	101	106
H_2 absorbed per gall., cu.ft.	180	160
Properties of spirits—		
Sp. gr. at 15° C.	0·810	0·830
Amount boiling below 100° C., %	17	18
Aromatic hydrocarbons, %	25	29
Unsaturated ,, ,,	1	2
Saturated ,, ,,	74	69
Octane number	70	70

The spirits shown in the table have a rather high specific gravity and a rather low volatility. These can be improved as our knowledge of catalysts has now increased. Also, although low-temperature tar can be treated in the vapour phase only, the rate of deterioration of the catalyst is rather high and the addition of a preliminary liquid-phase treatment would make a more satisfactory process.

The treatment of high-temperature tar would certainly involve a two-stage process, a preliminary liquid-phase treatment being necessary to separate free carbon and other untreatable matter and provide a suitable material for the vapour phase. It has been found that vertical-retort tar can be dealt with in the liquid phase in such a manner (Report of Director of Fuel Research, April, 1937) that the whole, with the exception of the free carbon only, can be converted into oil suitable for vapour-phase treatment. With the more highly-cracked tars obtained from discontinuous retorts it is certain that, in our present state of knowledge, a proportion of the pitch would have to be rejected after the liquid phase treatment.

Certain results obtained by the liquid-phase treatment of a vertical-retort tar are given in Table 7. The catalyst used in this case was the best of a large number tried. In one passage through the converter 100 parts of tar gave

TABLE 7.—*Hydrogenation of High Temperature Vertical Retort Tar*

Catalyst		None	0·5% ammonium-molybdate 0·25 ' hydriodic acid
Original tar—			
Water yield, % by wt. of dry tar	1·0	1·3	5·2
Sp.gr. crude oil product	1·091	1·025	0·946
Crude oil product, yields as wt. percentages of dry tar—			
Yield	..	92·4	86·9
Distillate to 300° C.	36·0	48·8	65·3
Residue at 300° C. (recycle oil)	64·0	43·6	21·6
Asphalt (pet. ether insol. material)	30·6	10·6	0·5
Tar acids	11·2	14·9	9·5
Spirit to 200° C.	5·0	10·1	20·2

86·9 parts of "oil," of which 65·3 parts boiled below 300° C. and were suitable for transfer to the vapour phase. The remaining 21·6 parts would be recycled until reduced in boiling point below 300° C. In treating this tar it may be preferable to remove the free carbon outside the converter by diluting the tar with recycle oil and centrifuging the mixture. By combining this liquid-phase treatment with vapour-phase hydrogenation of the distillate to 300° C. a volume yield of spirit of 100% was obtained from vertical-retort tar.

Horizontal retort and coke oven tars are much less promising raw materials. Only a preliminary examination of these has as yet been made, but it appears that as much as 40% of these tars may be refractory to hydrogenation and may have to be discarded from the liquid phase. This result may be improved upon, but it is doubtful at present whether the hydrogenation of such tars will ever be worth while.

Of the total tar made at gas-works (228,000,000 galls. in 1935) more than half is produced in vertical retorts. The treatment of the whole of this tar would yield some 120 million galls., or about 9% of the national consumption, of motor spirit.

There is no technical reason why the production of motor spirit from vertical retort tar should not be commenced in the very near future. Certain information with regard to the optimum conditions of treatment is still lacking, and it remains to be discovered within what precise limits the composition of the tar may vary while still remaining suitable for the process. But these researches could soon be pushed to completion if they were likely to find any immediate application in industry.

If satisfied that the economic position is favourable, the Gas Industry has two alternatives open to it in the exploitation of the hydrogenation process:

(*a*) It may remain content to sell its tars and tar products, or

(*b*) it may erect its central hydrogenation plant or plants.

Conclusions.

In his day William Young was both a research worker and a pioneer. The modern research worker, with his wider knowledge and better facilities, is indicating to a greater extent not only the possibilities of improvements in existing technique but also of radical changes. It cannot be too strongly emphasized, however, that research work is only a means to an end and that its full value cannot be properly realized without trial on a technical scale. The developments now indicated have been out-

lined in this Paper, although some of them are only in an early stage of investigation and some may never justify application; all, however, seem worthy of technical examination.

The main objective of these developments is the finding of new outlets for the main products of the Industry. For each of these products new uses are being indicated and variations in technique will become necessary if these uses are to be established and extended. It is suggested that, by establishing as many variations as possible in its products, the Industry can acquire a flexibility which should overcome the difficulties caused by seasonal and other variations.

Were gas the sole product of the Industry, as in the case of complete gasification, a measure of flexibility could be attained by extending the utilization of the gas through, for example, compressed gas or hydrocarbon synthesis. It would seem more promising, however, that the Gas Industry should become a " solid fuel " industry to a greater extent and, by varying the proportions of many products to the immediate demand, so balance its production as to achieve better results as regards maintenance of output at all seasons.

The many developments possible fall into several classes:

(i.) Those immediately applicable in any works—*e.g.*, the production of special cokes.

(ii.) Those showing promise but requiring further scientific and/or technical development—*e.g.*, gas enrichment.

(iii.) Those requiring organization by the Industry as a whole—*e.g.*, high-pressure gas.

(iv.) Those requiring a special effort by large undertakings or by groups—*e.g.*, the synthesis of hydrocarbons or the hydrogenation of tar.

It is apparent that the most attractive developments are those which provide raw materials suitable for steady markets which are relatively unaffected by seasonal changes, as, for example, gas for motor transport. Such developments therefore merit examination first, but the adjustment of the rate of production of the many diverse products would seem to be the way in which the best interests of the future of the Industry would be served.

The Author wishes to thank the Director of Fuel Research and the Department of Scientific and Industrial Research for permission to publish this lecture.

Proposing a vote of thanks to Dr. King, Mr. DAVID VASS (Perth) said that the North British Association, and, indeed, the whole Gas Industry, were indebted to him for a comprehensive survey of research work in the manufacture and purification of gas and by-products, and for his suggestions as to the possibility and advisability of varying their methods of working, by utilizing the flexibility of the modern gas plant to meet variations in demand. Taking one example only, at the time when the value of surplus coke was low, it was found possible to adjust the working of the plant by increasing the yield of gas and thereby reducing the quantity of surplus coke for sale, thus increasing the average price, whereas to-day, with the higher market price for coke, it might be found more economical to revert to lower yields of gas, so as to have more coke available for sale. Dr. King's suggestions for improving the quality of coke and of new markets for coke were worthy of consideration.

Dr. King had given them valuable information regarding the Carpenter-Evans process and other processes, and he hoped for further improvements in the removal of sulphur compounds by means of plant working at high temperatures as used in large gas-works. If further research (with contact-material of a high space capacity) but working at temperatures not exceeding steam temperature, could be found, it would be more applicable to the medium or smaller-sized works.

Mr. THOMAS CARMICHAEL (Portsmouth), seconding the vote of thanks, referred to the business acumen which is being applied at the Fuel Research Station in their outlook upon modern problems. The work which they were doing, and especially the part referred to in the present Lecture, was of the greatest interest not only to the North British Association, but to the whole Gas Industry.

Dr. KING briefly responded.

Trade Notes

Underpressure Engineering Company, Ltd.

The new list of the Underpressure Engineering Company, Ltd., 70, Victoria Street, S.W. 1, who, as is well known, are manufacturers of underpressure connections, valve connections, split tees, and all tools for mainlaying, presents a comprehensive selection of these articles. For their new improved split gas tees, perfect safety is claimed for the workmen, there are no bags to insert, and no loss of gas. For gas, water, steam, drainage or oil, the Company have manufactured their branch connections, which can be fitted without interfering with flow or pressure. Other specialities include valves, hydrants, manhole covers, and valve and surface boxes, all standard patterns and sizes of which are in stock. There is also a wide selection of such articles as taps and dies, reamers, drills, and pipe cutters.

Concrete Utilities, Ltd.

For the recent annual conference of the Association of Public Lighting Engineers, Concrete Utilities, Ltd., Great Amwell, Ware, Herts., erected in Shorncliffe Road several of their Avenue 4 type tall lighting standards, each with a bracket for a specific purpose. This firm, with many years' experience of this class of work, claim to be the pioneers in Great Britain of concrete columns for street lighting; their 40 designs include those for side streets and highways and vary from classical to the most modern ideas applicable to concrete.

These columns have been erected in places extending from Cornwell to Banff and from Singapore to Bermuda, and the many thousands already erected are standing advertisements to the quality of the Company's products. Present orders include some thousands of a special type for one of the largest Gas Companies in the South of England.

The firm's large experience of design, specification, and practical manufacture enables them to use the process most suitable to any particular type of column, the methods of spinning, vibration, or jolting being used separately or in combination as required to produce the best result. The years of practical experience have also eliminated faulty designs and methods so that clients have the advantage of proved work both in appearance and endurance. Although the Company are specialists in both design and construction they welcome special designs from clients that may be possible to carry out in the material.

" Jiffy " Automatic Clothes Washer.

The Jiffy Automatic Clothes Washer Company, Ltd.—a pioneer in the Washing Machine Trade—found it necessary to trade direct with the public, owing to the lack of interest and support by gas undertakings in the early days of the washing machine. Having now created a wide demand for its washers, the Company has decided to cease all direct selling activities and to place its extensive specialized direct selling force at the disposal of gas undertakings. The scheme which has been formulated is a most attractive one, and includes demonstration in the home of the prospect, while there are no onerous conditions attached to the plan which is available both to the many undertakings already handling the " Jiffy," and to others who have not yet done so.

The new policy and selling plan are to open on Oct. 1 next. Among other things, showroom demonstrations can be arranged, and other valuable sales aids, such as circularizing, showcards, and local publicity, are included in the scheme. This presents an excellent opportunity for increasing gas sales with little or no effort or expense.

All those who are interested in the sale of washing machines are invited to communicate with the Jiffy Automatic Clothes Washer Company, Ltd., Accrington.

EXPERIMENTS BY THE SOUTH METROPOLITAN GAS COMPANY

on the Preparation OF Thin Tar Carpets

The South Metropolitan Gas Company have recently been engaged in experiments connected with the development of thin carpets containing tar binders. Insufficient time has yet elapsed for definite conclusions to be drawn from the experiments; but in view of the importance of the problem of preparing satisfactory carpets, the Company have—as mentioned in an Editorial note in last week's "JOURNAL"—published a preliminary report, from which the following is abstracted.

Thin bituminous carpets constitute an important modern development in road treatment; before their introduction, bituminous road carpets could be divided into two main groups—asphalts of close texture and low void content, and tar-macadam of open texture and high void content. These latter materials are, of course, still used extensively; they are usually applied to a prepared foundation in one or more layers having a total thickness of 2-4 inches. Asphalts, being relatively costly materials, are used chiefly on roads carrying heavy traffic such as those in urban areas. The majority of country roads are of tar-macadam or water-bound construction which require periodical surface treatment to maintain them in satisfactory condition.

In the past this treatment invariably consisted in the application of a surface dressing of a film of bituminous binder and a layer of stone chippings or shingle, but this process has now been replaced to some extent by the use of "thin carpets." With modern improvements in binders and technique there is little doubt that surface dressing will continue to provide a cheap and effective means of maintaining a road surface, but the method has certain limitations and disadvantages which are avoided by the use of thin carpets, and as a result the new method is becoming increasingly popular.

A "thin carpet" may be defined as a mixture of aggregate and binder which is normally applied in a layer about 1 in. thick to a stable road surface with the primary object of providing a "non-skid" wearing surface requiring no further treatment for at least three years. It is usually of low mechanical strength, being intermediate in properties between tar-macadam and asphalt. Its use avoids the scattering of stone by traffic and the bleeding of binder which sometimes occurs with surface dressings; but the main advantage of a thin carpet is probably that it can be used to restore the good riding properties of a road which has become corrugated or otherwise mis-shapen, without resorting to reconstruction. A thin carpet can also be used as a substitute for tar-macadam topping in new road constructions, thus avoiding the necessity for surface sealing.

Thin carpets in this country can be divided into three main groups:

(*a*) Open graded carpets containing aggregate of maximum size about $\frac{3}{4}$ in.

(*b*) Finely graded carpets containing aggregate of maximum size about $\frac{1}{8}$ in.

(*c*) Finely graded carpets into which are pressed pre-coated chippings of about $\frac{3}{4}$ in. in size.

Groups (*a*) and (*c*) produce rough types of surface and group (*b*) a smooth sand-paper surface. Motorists generally show a preference for the rough type of surface since they feel, although possibly without justification, that it affords a better grip than the sand-paper type. The Company's experiments therefore have been confined to the open graded carpets. So far no large-scale trials have been made of group (*c*), since it has been felt that the application of such materials might require special technique not possessed by ordinary laying gangs.

To be satisfactory a thin carpet must, *ipso facto*, fulfil the purpose for which it is intended. It must therefore be cheap, be easy to apply to the road, produce a non-skid surface and have an effective life of at least three years. The carpet should also be capable of carrying traffic immediately after rolling and should preferably become light in colour within a short time after application.

The development of a specification for a thin carpet is facilitated by consideration of the various reasons why a carpet might fail to attain the required length of life; for it is then possible to take the necessary steps to avoid these possible causes of failure. A carpet might fail for the following reasons:

(1) Initially it might be so low in mechanical strength as to be unable to withstand the action of traffic.

(2) It might become unduly soft and therefore deformed by traffic in hot weather.

(3) The binder might "bleed" to the surface in hot weather, thus destroying the non-skid nature of the surface.

(4) The carpet might become so hard and brittle in cold weather as to be unable to withstand traffic shocks and the effects of frost without fretting of the surface or even complete disintegration.

(5) The binder might be removed from the aggregate by the action of water with resultant disintegration of the carpet.

(6) The binder might harden unduly as the result of exposure, leading eventually to failure of the carpet by disintegration as in (4).

(7) The aggregate itself might wear to a smooth surface having inadequate non-skid properties.

A specification for a satisfactory thin carpet must be based on the properties of both the binder and the aggregate of which the carpets are composed.

Design of a Thin Tar Carpet.

Since the properties of tar are capable of appreciable modification, it is possible, within limits, to produce a tar having the properties required to make it most suitable for use in thin carpets. Let us consider what those properties should be. The facility with which a carpet can be handled and consolidated depends mainly upon the viscosity of the tar. From this aspect it is therefore desirable that the viscosity should not be very high. For example, a tar resembling a soft pitch, having an E.V.T.* of, say, 55° C., would render a thin carpet very difficult to lay and consolidate in any but the hottest weather conditions. The stability of the carpets after rolling also depends to some extent on the viscosity of the tar, although the shape and grading of the aggregate are probably equally important. Since the carpet must be sufficiently stable immediately after rolling to carry traffic, the viscosity of the tar binder must not be low. To avoid failure due to lack of stability in hot weather and brittleness in cold weather, the variation in viscosity of the tar with temperature should be as low as possible. Reduced temperature susceptibility is best obtained by the addition of filler to tar of fairly low viscosity. The amount and type of filler used should be such that the ductility of the binder is not seriously reduced.

In a carpet the binder forms a very thin film on the aggregate, of the order of 0·002 in. thick. If it is fully exposed it will therefore tend to harden rapidly, much more rapidly than the binder in a surface dressing, which may be nearly twenty times as thick and is protected to a considerable extent by the blinding material. The degree of exposure of the tar film in a carpet can, of course, be minimized by reducing the void content of the aggregate, but since the carpet is required to have a rough surface, the reduction in voids which may be made is limited, and it is therefore desirable that the tar should be one that hardens slowly on exposure.

The adhesion of tar to stone is generally satisfactory, and it does not appear to be necessary to make any special modification to tar to improve its adhesive properties.

* "Equi-Viscous-Temperature"—the temperature at which the tar has a viscosity of 50 sec. on the standard tar viscometer.

However, a high viscosity and a degree of plasticity such as is given by the addition of fillers are useful in helping to prevent stripping of the tar from the stone by water. An important factor in regard to adhesion appears to be the surface characteristics of the stone; the stone therefore requires special attention in this respect.

It is, of course, highly desirable that the choice of aggregate for a thin carpet should not be restricted to one or two types of stone; the specification should be such that as many as possible of the different available types may be used. However, certain characteristics are essential in a stone in order that it may be suitable as a carpet aggregate.

The stone should be of angular or irregular shape and should not contain more than a small proportion of rounded stones, which reduce the stability of the carpet, or of flaky stones, which fracture easily. The surface texture of the stone should be such that the adhesion of the binder is satisfactory—*i.e.*, it should be smooth, granular, or finely crystalline and should not be glassy or coarsely crystalline. The porosity should be low, for if the stone is wet the presence of a large amount of water in the pores will render the process of drying difficult, and if drying is incomplete, the adhesion of the binder will be poor. Also, at the temperature of mixing, the tar is sufficiently low in viscosity for a certain amount to be absorbed into the pores of the stone, reducing the amount available to give cohesion to the carpet. The mechanical strength of the stone should be sufficiently high to prevent the carpet becoming smooth as the result of the crushing action of traffic. It is unnecessary, however, for the stone to have such a high mechanical strength as is required for surface dressing purposes. In fact, a small amount of crushing under traffic such as occurs with slag is probably advantageous in reducing the voids in the carpet. The minimum figure for crushing strength of 10,000 lb. per sq.in. suggested by Knight for aggregate for tar-macadam is probably satisfactory as a minimum for thin carpet aggregate.

There should be no difficulty in finding examples of most types of stone which fulfil the above essential requirements. It now remains to consider the grading most suitable for thin tar carpets. Grading can, of course, be more or less completely specified. To obtain the rough non-skid type of surface it is evident that the maximum size of aggregate should be as large as possible, at least ½ in., and possibly larger. The maximum size of aggregate which can be used is governed by the required thickness of the carpet. In order that the carpet shall in no place be less than two stones thick, the consolidated thickness must be at least 1½ times the gauge size of the largest stone. A carpet containing ½ in. stone must therefore be at least ¾ in. thick, and one containing ¾ in. stone at least 1 in. thick. The need for a rough surface suggests that the grading should be of the open type and should not be such that the carpet is virtually voidless. At the same time it is necessary that the access of air to the thin film of tar on the aggregate should be restricted, otherwise even the use of a slow-ageing type of tar would not prevent undue hardening by evaporation. A single grade of stone such as is used in tar-macadam topping gives a void content in the consolidated carpet of about 35%, which obviously allows free access of air to the tar. In addition, an open-texture carpet of this type is completely pervious to water and frost, and thus very liable to disintegration by those agencies. A reduced void content is thus necessary. This can be brought about by the addition of a proportion of smaller grades of stone and of fine material such as sand. The void content which forms the best compromise between the two opposing requirements must be a matter for experiment. It will depend to some extent on the nature of the stone used, for when certain of the softer stones are used the carpets become rapidly lower in voids under traffic as the result of crushing of the stone. This "closing up" of the carpets is, of course, highly desirable from the point of view of the durability of the carpet provided it does not lead to the loss of non-skid properties.

In addition to the properties of the ingredients outlined above there are a number of conditions of manufacture which would appear to be essential for a carpet to be satisfactory. The stone must be adequately dried to ensure adhesion of the binder, but the temperature at the time of mixing should not be so high that the E.V.T. of the binder is unduly raised by evaporation losses. Accurate proportioning of the ingredients of the carpet is, of course, important.

Experimental Development of a Thin Carpet Specification.

It was evident from the first that work on thin tar carpets would be greatly facilitated by developing a specification as far as possible in the laboratory before any material was manufactured in a full-size mixing plant.

For the purpose of making carpeting material in the laboratory a 3-cwt. Stothert and Pitt hot mixer was used. The consolidation of the experimental mixtures prepared in this mixer presented a somewhat difficult problem. In the early work the carpet was rolled on the ground between battens by means of a heavy hand roller. This was not found to be very satisfactory because consolidation was insufficient and the consolidated carpet could not be handled for testing purposes. However, a rolling machine similar to that described by Adam and Murdoch* enabled specimens of carpet 1 ft. square to be consolidated under conditions approximating to large-scale practice.

It has been found that samples of carpet of all types can be consolidated in this machine to densities closely similar to those obtained by rolling on the road. Enormous pressures would be required to obtain the same degree of consolidation of such a large specimen by direct pressure in an hydraulic press. Consolidation by roller also has the advantage that it produces the same process of orientation as that which the aggregate receives during laying on the road. The samples are of convenient size for the measurement of the density and void content and for the application of mechanical tests.

In the early stages of the development of the carpet there were no standards as regards mechanical properties to which the experimental batches could be prepared. The suitability of a specification for trial on the large scale was therefore judged as the result of visual examination of the carpet, measurement of void content, and rough tests for cohesion and mechanical strength. As a part of the visual examination, attention was given to the behaviour of the material on rolling, since this gave a good indication as to whether the quantity of binder was excessive or inadequate; an excess of binder caused the material to push unduly under the roller, and a deficiency gave rise to poor cohesion of the aggregate. It was also possible to observe the approximate range of temperature over which the carpet could be adequately consolidated.

TABLE 1.—*Specification for Experimental ¾ In. Gravel Thin Carpet.*

Coarse aggregate	1 part ¾ in. grade 1 part ⅜ in. grade
Fine aggregate	Coarse sand
Filler	Limestone

Aggregate to consist of 79% coarse aggregate, 16% fine aggregate, and 5% filler. The mixture to have approximately the following grading analysis:

¾ in.–½ in.	25%
½ in.–⅜ in.	25 ,,
⅜ in –¼ in.	20 ,,
¼ in.–⅛ in.	10 ,,
⅛ in.–85 mesh	10 ,,
85–200 mesh	5 ,,
Passing 200	5 ,,

The carpet mixture to consist of 94·5% aggregate
5·5 ,, tar binder

For cold weather application binder to have E.V.T. of 25° C.

In the first experiments gravel was chosen as the aggregate for the reasons that it was cheap and was available in large quantities in the London area. Many surveyors and contractors were therefore anxious to use it in road construction and surfacing to the greatest possible extent. The gravel used was from a pit in the Thames Valley and was one which had given good results in surface dressing work. A number of trial mixtures were made, and as a result the specification given in Table 1 was considered sufficiently promising for trial on the road. The void content of the carpet was reduced to 22% by using mixed grades of stone and by the addition of sand. Equal parts of ¾ in. and ⅜ in. stone were used and the sand was fairly coarse. It was thus possible to obtain a grading analysis of the mixed aggregate without large gaps and with fairly uniform steps from the maximum size to the minimum size. It will be noticed from the table that the grading efficiency of the samples of gravel used was not high; but this was not unusual, and was considered to be an advantage rather than a disadvantage since it helped to give a smooth grading curve for the carpet aggregate. A smooth grading curve was aimed at since it was considered that segregation of the different sizes of stone would thereby be minimized both in transporting and laying the carpet.

The experiments suggested that the carpet should contain 5·5% of binder. The viscosity of the binder, it was considered, would be dependent on the season of the year. In the cold weather in which the experiments were carried out it appeared that a tar of E.V.T. 25° C. (which with an equal amount of Portland cement filler would give a mixture of approximately 37° C. E.V.T.) would be suitable.

* "GAS JOURNAL," Jan. 10, 1934.

The most suitable ageing properties of the binder could only be decided by experience.

When granite was substituted for gravel in the specification, it did not appear that any important alteration was necessary.

An opportunity was afforded in February, 1935, for road trials of the experimental carpet to be made. A 100-yd. length of a suburban main road was placed at the disposal of the Company, and the normal gangs were provided by the local authority for laying the carpet. Arrangements were made for both gravel and granite carpets to be prepared by a local firm of contractors who possessed a standard Millar hot asphalt plant. In the specification supplied to the contractors it was stipulated that the stone was to be dried and warmed to a temperature between 120° and 140° F. and the binder to be heated to a temperature of 180° F. The filler was to be added to the aggregate after coating with tar.

The existing surface of the road consisted of surface-dressed tar-macadam in good condition, although somewhat smooth. One-half of the road was treated with a light dressing of tar emulsion and the other half was left untreated. The carpets were distributed by warm rakes to an unconsolidated thickness of about 1½ in., and consolidated by means of a 6-ton steam roller to a thickness of about 1 in. One ton of carpet covered an area of about 22 sq.yd., and about 25 tons of each type of carpet were required to cover the 100 yd. of road. No difficulty was experienced in distributing and rolling the carpets. A small portion was laid quite easily the day following manufacture, although the weather at the time was cold, with air and road temperatures of 35°-38° F. With the object of reducing surface voids of the carpet as far as possible without affecting the roughness of the surface, a sand-tar

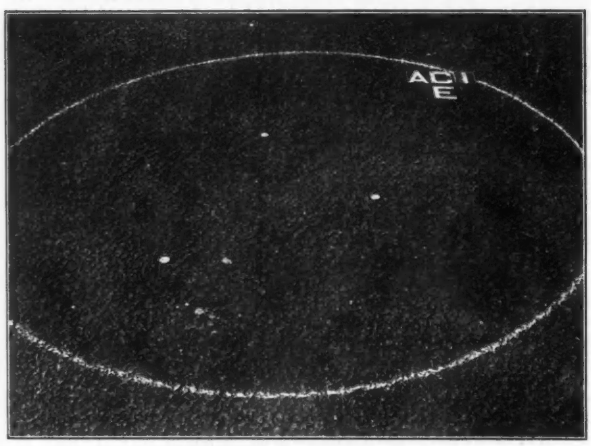


Fig. 1.—First Experimental ¾ In. Granite Tar Carpet Four Days after Application.

dressing was prepared by mixing sand with 6% of tar, and this was brushed over the carpet on the day following application. The appearance of the finished surface is shown in fig. 1, which is a photograph taken a few days after the work was completed. Both types of carpet were considered to be promising by both the surveyor and the contractor. The gravel carpet perhaps attracted more attention in view of the cheapness of the aggregate. While the carpets have not been entirely satisfactory in behaviour, they are still in fair condition at the present time after minor treatment only, and it has not been necessary to make any radical alterations to the basis of our specification for thin tar carpets. The specification of these early carpets has formed the basis for the specifications of all thin carpets with which the South Metropolitan Gas Company has been concerned. The defects that developed in these experimental sections during the following summer and winter all appeared to be capable of prevention by relatively minor modifications in the specification. A brief account of the behaviour of the carpets is therefore of interest.

The carpet was initially pervious to water as shown by the rather long period required for drying after rain; however, no defects of any kind developed during the remainder of the winter and the spring. The consolidation given by traffic caused the carpet to become progressively more waterproof. On the advent of hot weather the carpet became soft to the foot, but was not displaced in any way by traffic, and the road has remained of good shape to this day. Unfortunately, bleeding of the binder to the surface also occurred in places. This was first noticed on that portion of the road which had been treated

Fig. 2.—First Experimental ¾ In. Gravel Tar Carpet Twenty-Seven Months after Application.

with emulsion. This suggested that either the use of emulsion was inadvisable on a previously tarred road, or that when emulsion was used a smaller quantity of binder was required in the carpet. Subsequently the bleeding extended to a large proportion of the total area of the carpet and it was necessary to resort to gritting of the surface to remedy the trouble. It was concluded that the binder was present in a slightly excessive proportion and that the viscosity was probably too low.

During the following autumn a somewhat unexpected, and for a time disquieting, defect developed. This consisted in the removal of the binder from the aggregate in localized areas in the traffic wheel tracks, resulting in a few cases in the development of footholes requiring patching. The binder displaced was found to be present in globules between the aggregate, and it was still soft and adhesive. It was noticed that the experimental road formed a route taken by lorries from a nearby gravel pit, and the drippings from the lorries during a period of abnormally wet weather kept the road almost continuously wet with water containing clay and sand. It was concluded that the removal of the binder was the result of the reduction in the interfacial tension between the water and the tar by the clay suspended in the lorry drippings, with a consequent reduction in the contact angle between the tar and the stone. The removal of the binder was rendered easier by reason of its low viscosity. In later experiments in which binder of high viscosity was used, this phenomenon has not again been observed, and in the first experiment the hardening of the binder during the following summer was sufficient to prevent any recurrence of the trouble. Figs. 2 and 3 show the condition of the sections in May, 1937.

A further trial length of ¾ in. gravel carpet was, by the courtesy of the County Surveyor, laid on a trunk road in another county during June, 1935. The material was manufactured in the county council's own mixing plant, which was a small hot asphalt plant of normal type with a maximum output of 5 tons per hour. The aggregate used was from the same source as that used in the previous experiment, and had approximately the same grading

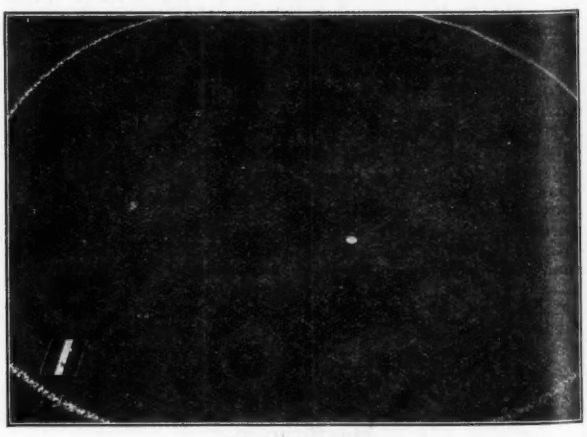


Fig. 3.—Close View of Experimental Granite Carpet after Twenty-Seven Months.

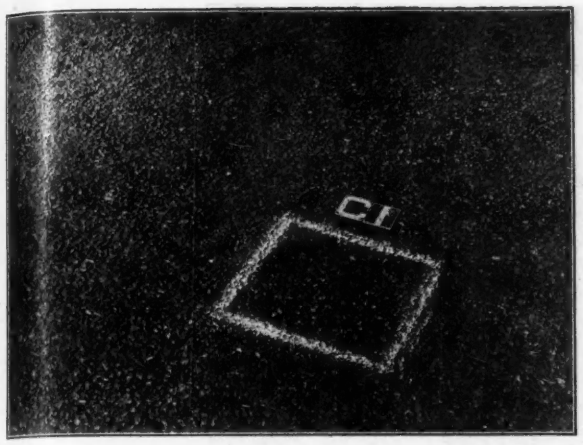


Fig. 4.—Experimental ¾ In. Gravel Carpet on Trunk Road Twenty-One Months after Application.

analysis. The carpet contained 5% of tar binder of viscosity equivalent to 40° C. E.V.T. The quantity was lower and the viscosity higher than in the first experiment. The carpet was laid by means of warm rakes on a newly reconstructed super-elevated corner on a surface which consisted of tar-macadam in the centre of the road and concrete on the haunches. It was consolidated by an 8-ton roller to a thickness of about 1½ in. A surface application of tarred sand was made the following day.

In spite of very hot weather during and immediately following application, the carpet was not disturbed by the heavy traffic carried by this road, and no bleeding occurred. Apart from a little surface fretting, the carpet is still in good condition. A photograph of a portion of the surface in May, 1937, is given in fig. 4. The area marked in chalk was cut out for analysis, and it is of interest that considerable difficulty was experienced in cutting and removing the piece of carpet. The result of the analysis is given in Table 2 and shows that the carpet closely followed the specification in composition.

TABLE 2.—*Composition of Sample of ¾ In. Gravel Carpet Cut from the Road after 22 Months.*

Grading analysis of aggregate:	
¾ in.–⅛ in.	20 %
⅛ in.–⅜ in.	20 ,,
⅜ in.–¼ in.	18 ,,
¼ in.–⅛ in.	12 ,,
⅛ in.–25 mesh	12 ,,
25–52 mesh	7 ,,
52–85 mesh	4·5 ,,
85–200 mesh	2·5 ,,
Passing 200 mesh	4·0 ,,
	100·0 ,,

Soluble binder, 4·2%
Original binder content, 5·2% (assuming 10% free carbon and 10% loss of oils).

In the autumn of 1935 an opportunity was afforded the Company of carrying out thin carpet trials in a third county. In this case also the material was manufactured in the county council depot. The mixer used was an internally heated cone mixer designed primarily for the preparation of tar-macadam. Special arrangements were

Fig. 5.—Spreading Experimental ¾ In. Granite Thin Tar Carpet Mixture.

therefore necessary to enable carpet mixtures to be made. Calibrated measures were provided for obtaining the correct proportions of the aggregates, and the binder was weighed by means of a spring balance. Two different batches of carpet were prepared, using in the one case granite as the aggregate and in the other case Kentish ragstone, the maximum size being ¾ in. in each case. Laboratory trials indicated that rather more binder would be required by the ragstone, partly owing to the more absorbent nature of the stone, and partly to the larger

TABLE 3.—*Specifications for Experimental ¾ In. Granite and ¾ In. Ragstone Carpets.*

	(A) Granite.	(B) Ragstone.
Coarse aggregate	1 part ¾ in. grade 2 parts ½ in. grade 2 parts ⅜ in. grade	2 parts ¾ in. grade 3 parts ⅜ in. grade
Fine aggregate	Coarse sand	Ragstone dust
Filler	Ragstone filler	Ragstone filler
The mixed aggregate consisted of	75% coarse 20 ,, fine 5 ,, filler	89% coarse 6 ,, fine 5 ,, filler

The grading analyses of the mixed aggregates were:

	%	%
¾ in.–⅛ in.	19	18
⅛ in.–⅜ in.	19	11
⅜ in.–¼ in.	23	18
¼ in.–⅛ in.	14	19
⅛ in.–85 mesh	17	27
85–200 mesh	3	2
Passing 200 mesh	5	5

The carpet mixtures consisted of:

Aggregate	94·8%	94·0%
Tar binder	5·2 ,,	6·0 ,,
E.V.T. of binder	28° C.	28° C.

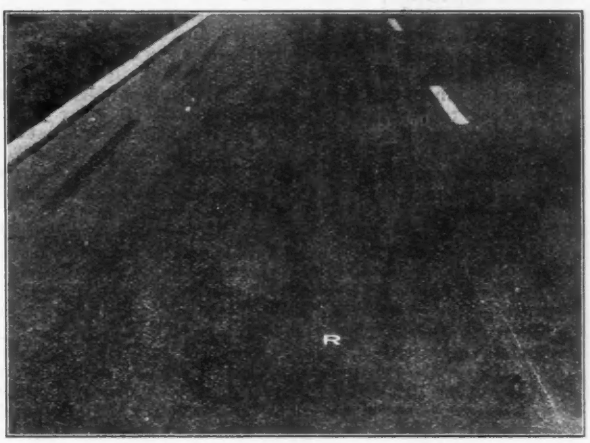


Fig. 6.—Experimental Ragstone Aggregate Carpet in May, 1937, Twenty Months after Laying.

proportion of fines accompanying the ¾ in. grade. The specifications for the two carpets are given in Table 3. The experiment was carried out in October and the weather conditions were very unfavourable. As the result of exposure to continuous wet weather the granite aggregate was very wet and gave difficulty in drying. During the first day of the experiment particularly, it was found impossible to dry the aggregate without exceeding the required maximum temperature of 160° F. Less trouble was experienced with the ragstone, since this was supplied dry and was stored under tarpaulins.

About 50 tons of each type of carpet were laid during cold weather on a 40 ft.-wide trunk road, which had been previously surfaced dressed, using ¾ in. chippings. The surface was not pre-treated in any way except for a strip of emulsion at the end of each section. The carpet was spread by warm rakes and consolidated to a thickness of 1 in. with a 6-ton roller. An area of 20 sq.yd. was covered by 1 ton of carpet. A photograph of the laying operations is given in fig. 5.

A portion of the granite carpet prepared during the first day of the experiments when mixing temperatures were high did not consolidate well and showed immediate signs of being unsatisfactory. About 5 tons were therefore replaced. In other respects both materials have proved satisfactory. The condition of the carpets in May, 1937, may be judged from fig. 6.

Since the period covered by the above experiments, other experiments and trials have been carried out, and as further experience has been gained several small modifications have been made to the specification. The amount of fine aggregate (below ¼ in. and excluding filler) has

Fig. 7.—Metro Veneer Carpet (½ in. Gravel Aggregate) on Trunk Road and Adjacent Footpath, Two Years after Application.

been increased from 15% to 20%, with a corresponding reduction in voids in the carpet from about 22% to 15%, and the application of the tarred-sand dressing has been discontinued as being unnecessary with the lower void carpet. New grades of carpet with maximum size of aggregate ½ in. and ¼ in. respectively have been introduced. The former has proved particularly suitable for a gravel aggregate, since the ½ in. stone is less liable than the ¾ in. stone to fracture under traffic impact. The ¼ in. grade of carpet has been developed for use on footpaths. The most suitable proportion of binder for these grades of carpet when using non-absorbent stone has been found to be 5½% for the ¾ in. grade, 5¾% for the ½ in. grade, and 6¼% for the ¼ in. grade.

A special tar binder under the registered name of "Metrix" has been developed for these carpets. This is a slow ageing material containing a proportion of colloidally dispersed coal (B.P. 316897), with an E.V.T. of 29°-31° C. during the winter months, and 34°-36° C. during the summer months.

Concurrently with the large-scale experiments, investigations into the properties of thin carpets have been carried out in the laboratory, using tests for mechanical strength to evaluate the carpet mixtures prepared on a small scale. From a study of the hardening of carpets which proceeds during the first few days after manufacture, it has been shown that this is due partly to evaporation of oils from the binder and partly to internal changes in the mixture. The rate of hardening was found to increase as the temperature was raised. Further, it was found that with any particular composition of carpet the mechanical strength was dependent on the temperature and the viscosity of the binder. Useful information has also been obtained on the effect of variations in the composition of carpets and this has enabled the thickness of binder film on the different sizes of aggregate to be calculated. As a result it has been possible to fix limits of tolerance which may be allowed in the grading of the aggregates and in the proportion of binder in the standard carpet mixtures. It has also been possible in experiments in which other gradings have been used to deduce the correct proportion of binder.

In the large-scale experiments the same type of specification has, so far, been used irrespective of the nature of the stone, although it is realized that certain of the details of the specification, which is designed primarily for stones of the gravel type, could probably be omitted in the case of certain of the softer stones. Further laboratory work is being carried out on the development of different types of specification which may simplify the manufacturing process and still further improve the behaviour of the material on the road.

The Commercial Development of Metro Veneer Carpet.

Certain surveyors considered the experimental sections of carpet sufficiently promising to continue the use of the material after a relatively short trial period, and for this reason commercial manufacture commenced as early as August, 1935. Since that date thin tar carpets to the South Metropolitan Gas Company's specification and under the name of "Metro Veneer Carpet" have been manufactured by two county councils and by five firms of contractors, and have been laid by fifteen different public authorities. A total quantity of about 30,000 tons of carpet has been laid, covering an area of about 600,000 sq.yd., which is equivalent to some 50 linear miles of road. The aggregates used have included gravel, granite, Kentish ragstone, and slag. Carpet has been laid on roads of all types and on a variety of surfaces, including surface-dressed tar-macadam, burnt-off surface dressing, concrete, stone setts, new water-bound macadam, and new tar-macadam base coat.

As more experience in the manufacture and in the laying of the carpet was gained, it became evident that a thin carpet was much more sensitive than tar-macadam to small changes in composition and the method of manufacture. This was, of course, to be expected, since a carpet is subjected to the direct action of the traffic, whereas tar-macadam is protected by surface dressing shortly after application. It thus became necessary to take special measures to ensure the uniformity of the carpet material. With the co-operation of the councils and the contractors engaged in the manufacture of the carpet, a system of control was therefore instituted. This can be divided into two parts, the first relating to the process of manufacture, and the second to the supervision of the process when in commercial operation. The first part of the system was, of course, only applied in those cases where a new source of supply of carpet was being considered.

Results Given by the Carpets.

As the road trials of Metro Veneer carpet commenced as recently as February, 1935, none of the material has yet been subjected to weather and traffic for three years. The two years during which most of the carpets have been in service, however, have been abnormally wet and have given rise to an unusual number of failures of thin carpeting materials. That the majority of Metro Veneer carpets are still in satisfactory condition and appear capable of giving at least three years' life would therefore seem to justify the belief that successful thin tar carpets of the rough surface type can be made without difficulty. The condition of a typical Metro carpet after two years' service is shown in fig. 7.

Success has not been invariable, and a few of the carpets made to the Company's specification have developed defects. However, a small percentage of failures is to be expected, particularly in view of the rapidity with which the manufacture of the carpets has developed. The defects have been confined almost entirely to carpets in which gravel has been used, and, of course, this stone is often considered to be an unsatisfactory aggregate. In the few cases where failure has occurred some special circumstance, such as an unwitting departure from the specification, has provided an explanation, and we feel that it has been established that satisfactory gravel aggregate carpets can withstand heavy traffic for a period of three years without becoming seriously affected.

On straight roads the speed and intensity of traffic have not had any great effect, and normally there is no marked difference between carpets carrying heavy traffic and those

carrying light traffic except a slightly greater tendency in the former case for the surface to become smooth. On the other hand, shearing forces which are produced on corners appear to be very severe on thin carpets, and with all types there is a greater tendency for surface fretting and disintegration to occur on corners than elsewhere. Urban traffic causes more severe wear than rural traffic, due no doubt to the shearing action of the braking and acceleration of vehicles on the urban roads. Consolidation by traffic is beneficial, and an almost complete absence of traffic usually leads to poor results unless the composition of the carpet is specially designed to meet these conditions.

Many interesting problems connected with the manufacture and laying of thin carpets remain to be investigated, but it is hoped that the experimental and commercial work reported in this Paper has shown that in this new development, as in other branches of road construction and surfacing, tar can maintain its position as an important modern road binder.

The Association of Public Lighting Engineers

Annual Conference at Folkestone

The Annual Conference of the Association of Public Lighting Engineers was held at Folkestone from Sept. 6 to 9 under the Presidency of Mr. C. I. WINSTONE, Public Lighting Superintendent to the Gas Light and Coke Company.

The Royal Pavilion Hotel, Folkestone, floodlighted by gas.

On Monday, Sept. 6, the Annual General Meeting of the Association was held in the Marine Gardens Pavilion—the Conference Headquarters—under the Chairmanship of the retiring PRESIDENT (Mr. E. C. Lennox, M.I.E.E., Newcastle-on-Tyne).

The Annual Report and Accounts were adopted, it being pointed out that the membership is increasing and that the funds are in a very satisfactory position.

Councillor BENWELL (Bournemouth) extended a cordial welcome to the Association to hold its Conference next year in Bournemouth.

Elections.

The result of the ballot for Officers and Members of Council was announced as follows:

President.—Mr. C. I. Winstone (Gas Light and Coke Company).

Vice-President.—Mr. C. H. Woodward (Bournemouth).

Members of Council.—Mr. H. W. Gregory (Superintendent, Northern Area, North Metropolitan Electric Power Company); Mr. H. V. Emptage (Public Lighting Superintendent, Margate); Mr. W. J. Bache (Borough Electrical Engineer, Cheltenham, and President of the Incorporated Municipal Electrical Association); Mr. J. Sellars (Manchester).

The PRESIDENT in asking his successor, Mr. Winstone, to take the Chair, mentioned that Mr. Winstone had been a Member of Council since the start of the Association and was one of the original members who assisted to found the Association.

A message of loyalty was sent to His Majesty the King, and the President said there was one other telegram which he knew the Conference would agree to. Dr. Carpenter, who had done so much in illuminating engineering and public lighting, was lying seriously ill at Hythe and had had a second stroke. It would be a pleasant gesture on the part of the Conference to send a telegram of sympathy and good wishes to Dr. Carpenter.

Mr. E. M. SEVERN (South Metropolitan Gas Company) seconded the suggestion, to which the Conference unanimously agreed.

Reception and Dance.

On Monday evening, there was a Reception and Dance at the Leas Cliff Hall by invitation of His Worship the Mayor of Folkestone.

On Tuesday morning the Association was given a Civic Welcome by HIS WORSHIP THE MAYOR OF FOLKESTONE (Alderman A. Castle). Speaking of conditions in regard to public lighting in Folkestone, he commented on the fact that the Folkestone Electricity Supply Company was under the control of the County of London Electric Supply Company, and the Folkestone Gas Company was under the control of the Gas Light and Coke Company, and added that Folkestone owed these concerns and their engineers and managers a great debt of gratitude for their co-operation not only generally but in providing, during the period of the Conference one of the finest displays of public lighting that had ever been got together.

The PRESIDENT, after presenting to Mr. Lennox the Past-President's Badge and Certificate, delivered his Address. This was published in the "JOURNAL" last week.

Mr. J. N. WAITE (Borough Electrical Engineer, Hull) proposed, and Mr. H. DAVIES (Gas Engineer, Chesterfield) seconded a vote of thanks to Mr. Winstone for his Address.

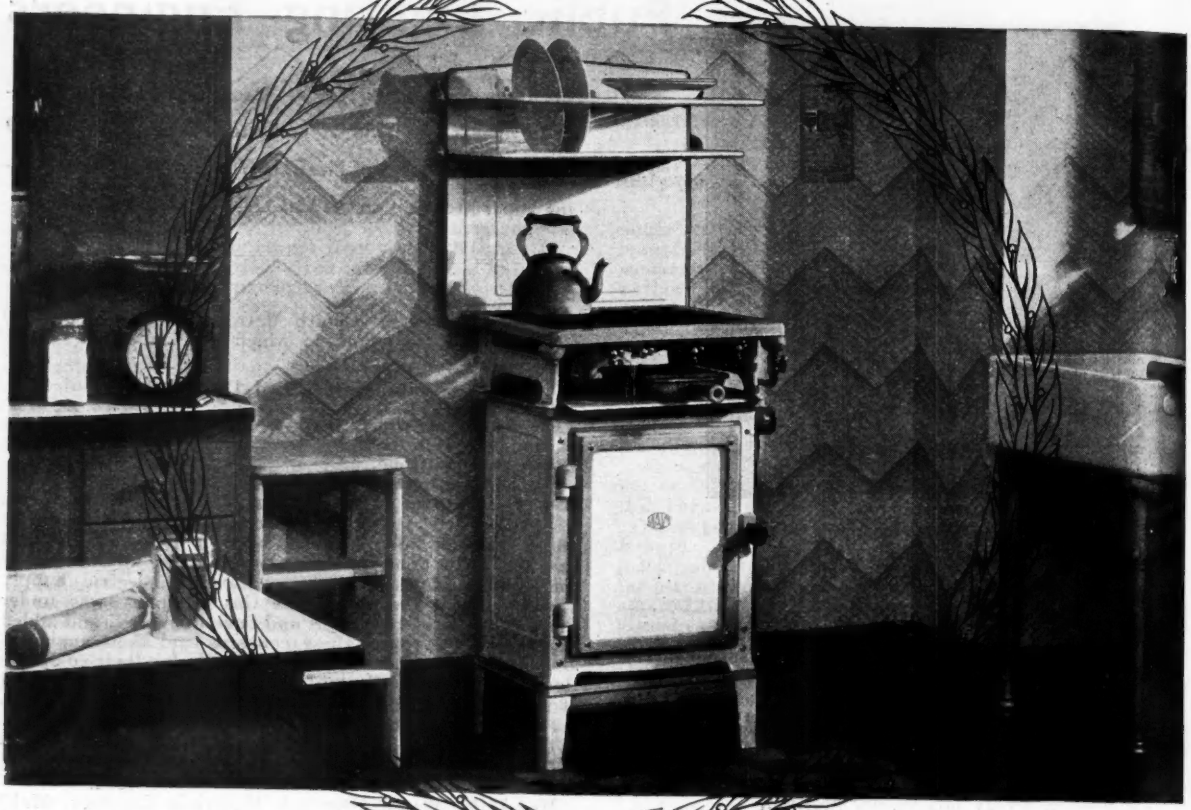
Entertained by the Gas Light and Coke Company.

On Tuesday a company of some 700 was entertained at luncheon at the Royal Pavilion Hotel, Folkestone, by the Directors of the Gas Light and Coke Company. The Chair was taken by Mr. R. W. Foot, General Manager of the Company and a Director of the Folkestone Gas Company.

Proposing "The Association of Public Lighting Engineers," the CHAIRMAN said that as a Director of the Folkestone Gas Company he would first like to take the opportunity of thanking the Folkestone Corporation, on behalf of the Chairman and Board of the Company, for the support which the Company invariably received from the Corporation and its officers. Remarking on the large representation present from local authorities in every part of the United Kingdom, the Chairman congratulated them on the great progress that had been made in public lighting in the country generally. In congratulating the municipal representatives, he admitted there was a business interest, because the more light local authorities wanted the more electricity and gas would be required. At the same time, as private citizens, they all appreciated the need for improved public lighting not only in the interests of public safety on the roads but because good street lighting had a psychological effect on the public and led to healthier and happier lives.

There were, he said, two very good reasons why the Gas Light and Coke Company was delighted to be the hosts on the present occasion. The Company was now celebrating its 125th anniversary and 125 years ago the first street in the world to be lighted by gas was Pall Mall. Gas had been used continuously since for the lighting of Pall Mall; and there were now nearly 60 miles of streets in London which were lighted by the Gas

Tribute to a fine product



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A friend seeing mine ordered one at once, and is equally delighted.

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Light and Coke Company. The second reason why the Company was delighted to be hosts was that Mr. Winstone was President of the Association.

Continuing, the Chairman said that for the last 14 years the Association had been meeting in Conference every year pooling knowledge, discussing the excellent research work which was carried out, and doing everything that could be done to provide a common pool of knowledge to make for greater efficiency in illumination.

It was also hoped through the work of the Association to extend the knowledge of the need for improved public lighting and to impress upon the country how great that need was.

He wished Mr. Winstone success and good health and prosperity during his year of office.

Mr. WINSTONE, in his response, having thanked Mr. Foot for presiding at the luncheon, said he regarded the lighting installations which had been specially put up in Folkestone a great achievement, for the like had never been seen before and it all proved that the Association had done good work.

Mr. Winstone said the Association did not intend to allow the occasion to pass without some slight token of recognition to Mr. Foot, and he asked him to accept a combined clock and penholder as a reminder of the occasion. It was inscribed "Association of Public Lighting Engineers Conference, Folkestone, 1937."

The CHAIRMAN expressed his thanks to the Association for the gift.

ANNUAL DINNER.

The Annual Dinner of the Association was held at the Royal Pavilion Hotel on Sept. 8. The President was in the Chair, and there was a large attendance, the guest of honour being the Rt. Hon. Sir Philip Sassoon, Bart., M.P. (First Commissioner of Works).

After the toast of "The King" had been honoured,

Sir PHILIP SASSOON proposed "The Association" and remarked at the outset that the wonderful examples of street lighting which had been erected in Folkestone for the period of the Conference ought to be an example not only to Folkestone but to all other seaside towns of the advantages of an adequate system of street lighting. He very much hoped that some modicum of this improved lighting would be allowed to remain, for to many these demonstrations had been a revelation in every sense of the word. Continuing, he remarked that in the short space of 14 years the Association had grown from an idea into an organization of major importance to the general public, for he was satisfied that without the work which the Association had done the appalling number of street accidents would be very much larger. An undue proportion of accidents took place at night due to the bad lighting which existed in so many parts and in remedying this the Association was fulfilling a vital need.

The PRESIDENT, responding to the toast, said there was not a town in England which was so well lighted as Folkestone was at that moment, and the installations had been put up to enable representatives from other towns to see how streets should be lighted. He reminded those responsible for the administrations of seaside towns in particular that well lighted towns were prosperous towns because visitors were attracted to them. In commenting on the fact that gas and electrical engineers were combining in this work of providing adequately lighted streets, the President said it was not the light in the lamp that mattered but the illumination on the road and he contrasted the general illumination of the streets of the country, poor as it was considered in many cases, with what it was 14 years ago when the Association was formed.

Mr. C. H. WOODWARD (Vice-President, and Lighting Engineer, Bournemouth) proposed "The Town of Folkestone" and coupled with the toast the name of His Worship the Mayor of Folkestone (Alderman A. Castle).

The MAYOR OF FOLKESTONE, in the course of his response, expressed appreciation of what the manufacturers of street lighting equipment had done in arranging the demonstration installations.

The final toast was that of "The Guests," which was proposed by Mr. J. H. CLEGG (Gas Engineer, Southport) and responded to by the Rev. A. MIDDLETON.

DISCUSSIONS AT THE CONFERENCE.

On Sept. 8 the Papers by Mr. George Keith on "High Intensity Gas Lamps," and by Mr. Dean Chandler on "Street Lighting by Gas with Special Reference to the High-Pressure System" were presented. These Papers were dealt with in the "JOURNAL" last week.

The PRESIDENT expressed the thanks of the Conference to Mr. Keith and Mr. Dean Chandler for the trouble they had gone to in arranging the demonstrations and said that few people imagined twelve months ago that it would be possible to get high-pressure lighting with low-pressure gas.

Mr. F. C. SMITH (Gas Light and Coke Company) said that having had some intimate contact with the developments described by Mr. Keith he knew only too well the difficulties that had had to be overcome, the physical problems which had had to be solved, and the tremendous amount of energy and initiative involved. His real reason for speaking, he said, was to remove misapprehension in the minds of certain delegates that this low-pressure lamp was really not a low-pressure lamp in so far as it required pressure in excess of the usual or ordinary distribution mains in order to work successfully. It was the fact, however, that the increased efficiency of the lamp was obtained with the usual pressure of 5 in. water gauge, and, indeed, lower pressures than normal distribution pressures could be used with this lamp. Therefore, it was definitely a low-pressure lamp and operated at ordinary distribution mains pressures.

Commenting on the somewhat unusual appearance of the syphon tubes, Mr. Smith agreed that when mounted at 25 ft. these syphon tubes were not very apparent, but added he had no doubt that sooner or later Mr. Keith would be able to reduce the height of these tubes considerably and still get the same effective increase in efficiency. This lamp was a very effective contribution to the appliances now available for street lighting, but the Conference should realize that in its present form it was only the first step, and higher efficiencies would be obtained with low-pressure gas as time went on. No doubt, also, there would be other methods of producing similar results. Much work of a similar kind was being carried out in other laboratories, but it had all been inspired by the pioneer work of Mr. Keith. Referring to the Supervia lamp, he said there was one point which needed special stressing—namely, that this lamp lent itself very readily to modification in distribution characteristics. It was possible to raise or lower the beam *in situ* by adjustment of the reflector dish in order to suit the distribution of the lamp to the particular road characteristics, so that as road surfaces became more polished the lamps could be modified to suit the conditions without any additional cost.

Mr. J. H. CLEGG (Gas Engineer, Southport) asked if any consideration had been given to the question of regeneration or recuperation so far as the gas and air were concerned, having regard to the high heat losses in the combustion of gas in the ordinary low-pressure lamp particularly, and also in the high-pressure lamp. After remarking that the developments which had been described that morning undoubtedly would inspire research workers in the Gas Industry to greater efforts during the next twelve months, Mr. Clegg said one interesting feature was that the readiness with which high-pressure gas lamps could be extinguished would be of great value in considering air-raid precautions. The developments that were taking place showed that public lighting costs would not be increased to any great extent, but that the service given to the public would be greatly improved in many cases with very little difference in cost.

Councillor L. F. BIDEN (Merton and Morden) asked for information with regard to the colour of some of the newer lamps which, he said, gave a rather whiter light than others. Had accurate measurements been made in the nature of quantitative analysis of the different spectrum colours to enable a comparison to be made between the new lamps and the older forms of gas and electric lamps? He also enquired with regard to maintenance costs of Mr. Keith's new lamp. His local authority, like many others, bought lighting at so much per lamp per year under a certain specification and it did not convey much to be told that a lamp burned so many cubic feet per hour. The local authority wanted to know the cost of a lamp of a certain size.

Mr. J. N. WAITE (Borough Electrical Engineer, Hull) asked what form of candle power Mr. Dean Chandler referred to in Table I, as it was not defined?

Mr. DEAN CHANDLER: It is the mean lower hemispherical candle power.

Light Output in Lumens.

Mr. WAITE said the context of the Paper indicated that this candle power purported to show the light output, but he suggested to the Author and to the Gas Industry as a whole that it did nothing of the sort. The mean lower hemispherical candle power was not a measure of light output; it was only a portion of the light output. On this point he said he was pleased the President in his Address had stressed the importance of referring to light output in terms of lumens, which constituted a true measure of light output. Mr. Keith had stated in his Paper that the low-pressure gas lamp gave about 200 lumens per cu.ft. and transferring that into the mean hemispherical candle power it gave 16 candle power, whereas Mr. Chandler gave 25 candle power. For high-pressure gas Mr. Keith gave a figure of 350 lumens per cu.ft. of gas which on the mean spherical candle power basis gave 28 whereas Mr. Dean Chandler claimed 42·5. This indicated that the lower mean hemispherical candle power was not an accurate measure of light output and he made a plea that for street lighting purposes, at any rate, light sources should be defined in lumens, which would enable accurate comparisons to be made.

Speaking generally on the question of street lighting, he said that a great deal had been heard about directive apparatus and other matters, but the first essential in street lighting was the provision of an adequate quantity of light itself, and this could only be measured as total light output in lumens. For many years, however, this had not appeared much in street lighting specifications and did not appear even now in the B.S.I. specification.

The PRESIDENT said he also held the view that whether the lamps were gas or electric the light output should be stated in lumens—namely, the amount of light that a lamp would put on to the road. There should be a certificate that the lamp was capable of putting so many lumens on the road where the light was wanted.

Mr. W. E. GREENHALGH (Lancs.) said he preferred to see lamps in operation on the road before buying them. Speaking of condensation, he said he had considerable trouble from this with the ordinary low-pressure lamp, and wondered whether this would be increased by the use of the large tubes in Mr.

Keith's new lamp. Again, wind resistance was an important thing, and with a wind of 65 miles an hour, which was not unusual in the North, he was wondering how the new lamp with its extra weight would behave. He also made the point that such lamps would require far more skilled attention than was ordinarily available, at any rate in small districts.

Councillor W. COOPER (Wandsworth) said he could speak with experience of Mr. Keith's early work of high-pressure lighting as far back as 1910 and had at that time been impressed by the amount of attention that had to be paid to the training of the maintenance staff, and in this connection he paid a tribute to the President for the work he had done in getting the ordinary lamp lighters and maintenance men to do their job well. In that connection he enquired whether the new Keith lamp could be adjusted by the ordinary man employed on street lighting maintenance work.

Mr. W. J. JONES (Lighting Service Bureau, E.L.M.A.) said the electrical industry would congratulate the Gas Industry on the work which Mr. Keith had done during recent years, and there was little doubt that the public was benefiting by this type of pioneer work whether it be done in electrical laboratories or gas laboratories. Speaking from the electrical side, he said he was not at all afraid or worried as to the effect which this new low-pressure lamp was likely to have, and he wished more power to the elbow of the Gas Industry, because better street lighting would result from this work. Continuing, he said that Mr. Waite and himself some years ago tried to obtain some information regarding the total light emission from high-pressure gas burners, but it was impossible to obtain that information from outside sources. They therefore sent some burners to be tested by the National Physical Laboratory, which now had magnificent gear for testing both low and high pressure gas burners. With a lantern containing three 1,500 c.p., nominal, high-pressure gas mantles of the long cylindrical type, it was found that the mean spherical candle power was actually 1,563 instead of the nominal 4,500, and the lumens were 216 per cu.ft. of gas in the lantern. Allowance, of course, had to be made for absorption by the reflectors and the globe, and he left it to others to make these allowances. In the case of the block type of mantle lantern, it was found that with the burner alone the light emission per cubic foot of gas was 276 lumens. Mr. Jones added that he thought the meeting would like to have these figures resulting from tests by the National Physical Laboratory in order to complete this important session on high-pressure gas.

The PRESIDENT remarked that after the figures given by Mr. Jones he could not understand how the Gas Industry ever sold a gas lamp. [Laughter.]

Dr. J. S. G. THOMAS (South Metropolitan Gas Company) remarked that, although there had been a great deal of talk about lumens and candle-power, the essential thing was output in candle-power, and he had adhered to that from the very beginning. Continuing, he said that Mr. Keith was a man whom the Gas Industry ought to be delighted to honour but he had not been honoured to anything like the extent he ought to have been. Finally, Dr. Thomas said he would like the Folkestone Conference to inaugurate a campaign "Back to Gas" and let that be the slogan. A good many people had gone from gas to electricity; there should now be the new slogan "Back to Gas."

An Invitation to Mr. W. L. Jones.

Mr. K. F. SAWYER (Gas Light and Coke Company) said he would like to correct the statement made by Mr. Jones, for if the figures were correct it was apparent that the National Physical Laboratory could not do any photometry. In the research laboratories of the Gas Light and Coke Company they had for years been concerned with the photometry of high and low pressure gas units and the results obtained had been confirmed in practice by such men as the President. The figures quoted by Mr. Jones were just about two-thirds or even less than those which the Gas Light and Coke Company had been obtaining for 10 years in high and low pressure gas lamps. Mr. Jones had quoted 216 lumens per cu.ft. of gas for high-pressure gas, but more than that was being obtained with low-pressure gas. The figure of 350 given in the Paper was the efficiency of the lamp including all the absorption in the glassware and the vitreous enamel reflector. It was a simple matter to set up a lamp and make a measurement, but it required a certain amount of knowledge of gas practice to ensure an accurate result. Once the technique had been established it was very simple to proceed along standardized lines and get an accurate result every time, but it was necessary to establish that technique, which the Gas Industry had done. Therefore, he would like to issue an invitation to Mr. Jones to come along to Watson House and measure for himself the lumen output of the lamps he had referred to. He could test any lamp he cared to select and he could also bring his own sub-standard lamp calibrated at the National Physical Laboratory. He would be provided with full facilities for checking up the Gas Company's apparatus and comparing the Gas Company's sub-standard lamps with his own. Mr. Sawyer said the Company's Research Department was able to confirm any of the results given in the Paper to be read by Mr. Smith and himself on the following day. He asked whether Mr. Jones would signify at once whether he would accept that invitation.

Mr. JONES said he would consider it, and added that he had made it clear that the figures he had quoted included the lantern and globes and that he had suggested allowance should be made for that. The instructions given to the National Physical Laboratory were to get the maximum light output and he would be glad to hear from Mr. Sawyer where it was suggested the N.P.L. had gone wrong in making the calculations.

Mr. SAWYER said he was sorry Mr. Jones had neither accepted his invitation nor refused it, and he hoped it would be considered.

Mr. JONES replied that he would consider it and at the same

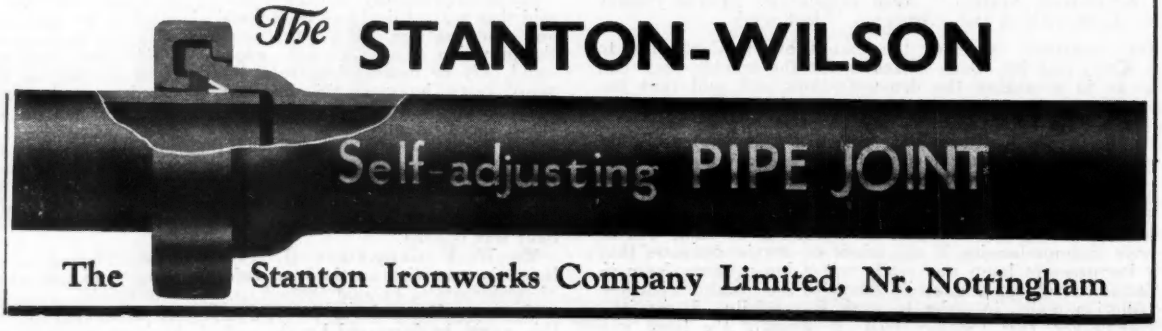
Traffic Vibration
Rigid or Self-adjusting Joints?

Not many of the problems brought into being by the remarkable growth of road transport during the last decade are capable of easy solution.

There is at least one exception, however. For instance, though much has been heard of the danger caused to historic buildings by traffic vibration, the harmful effects of such vibration on water and gas mains are not so apparent. To water and gas engineers responsible, however, for the maintenance of these essential public services, this was a very real problem until a few years ago, for rigidly-jointed mains could not be expected to withstand the severe vibration caused by modern conditions.

Some six years ago the Stanton Company introduced the Stanton-Wilson Self-adjusting pipe-joint to overcome this and similar difficulties. That it has successfully done so is proved by the fact that more than 1,500 miles of Stanton-Wilson mains have now been laid by over 750 public authorities.

The STANTON-WILSON



The Stanton Ironworks Company Limited, Nr. Nottingham

time he asked Mr. Sawyer to be good enough to examine the tests which the N.P.L. had made.

Mr. SAWYER said he certainly would.

The PRESIDENT suggested that if Mr. Jones accepted the invitation, the results should be published.

Mr. J. A. PROWSE (London) suggested that some consultation should be had with the N.P.L. in connection with this matter, for he was certain the authorities there would welcome any contribution that could be made to their methods of testing. He also suggested that in any such tests the officers making the tests, whether gas or electricity, should be given instructions that they should test the light given by the apparatus and then make adjustments in a similar manner to those made by the lamp manufacturer or the people responsible for the maintenance of the lamps in normal practice.

Councillor H. A. BENWELL (Bournemouth) called attention to the fact that although 75% of the roads of the country were side streets, practically no attention was being paid to these.

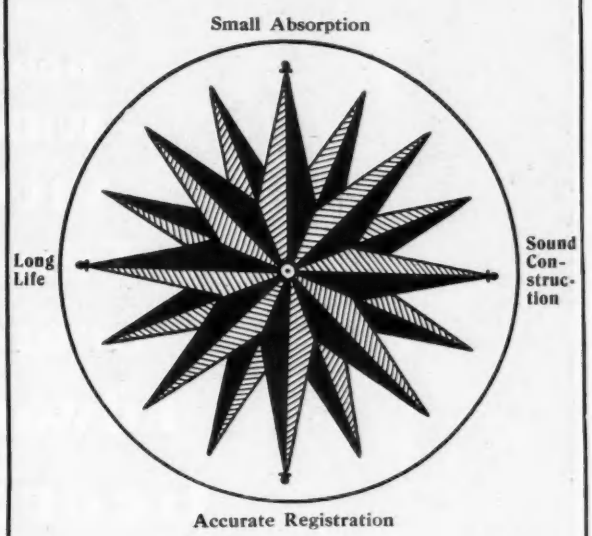
The Authors' Reply.

Mr. KEITH, replying to the discussion, said there must be a certain amount of height in the syphon tubes in order to get sufficient heat difference between the columns, but further experiment would no doubt make it possible to reduce this height. The lamp had only recently been completed and had been running in a rudimentary way for six months, but he had little doubt that the principle which had been evolved could be used with not such a great length of syphon tube. At the same time, when the lamp as at present constructed was hung up in the streets it was not offensive in appearance although at eye level the length of the tubes looked considerable. The point was that it was not only necessary to get the heat of the chimney gases into the air in the syphons but it was also necessary to get rid of the heat and get cold air in to give the pressure which was produced. Mr. Clegg was wrong in suggesting that apparently nothing had been done in the way of regeneration or recuperation, because in the high-pressure lamp that was the very first thing which was attended to. The gas/air mixture was heated up to as high a point as was practicable without the fear of pre-ignition of the mixture. If the apparatus became too hot, the mixture would begin to burn before it issued, but in this lamp regeneration and recuperation was used as far as it was possible to do so.

In reply to Mr. Biden, he said he was unable to give any maintenance costs, but it had been proved that the life of the mantles was very good due to the fact that they were well protected by having the secondary air excluded from them. He did not know what Mr. Greenhalgh meant by condensation in the syphon tubes. There had been no trouble in that connection. As to wind resistance, the actual surface exposed to the wind was not great, nor was the weight very great. The tubes and lining of the lamp were of aluminium and inasmuch as the lamp had 2½ times the capacity of the normal low-pressure lamp, a little extra weight was excusable. The adjustment of the lamps, mentioned by Mr. Cooper, was very simple indeed. There was a small pilot screw which enabled the lamp to be adjusted to give the optimum light. As to Mr. Jones' remarks, which Mr. Sawyer had effectively answered, he personally would have liked to be present at the tests in question. There was a certain amount of special technical knowledge necessary in adjusting these lamps to the particular conditions. The gas was not the same in every district; it might be of different composition and gravity, and this had to be taken into account in getting the best results from the lamp. It certainly was a fallacious reading to have only 216 lumens per cu.ft. for the one lamp mentioned and only 276 for the Supervia lamp. He agreed with Mr. Prowse that when such tests were made the makers should have an opportunity of seeing that their apparatus was given fair treatment.

Mr. DEAN CHANDLER also briefly replied and said that the slight difference which might have been noted in the colour of the light sources, mentioned by Councillor Biden, did not in any way indicate any difference in the composition of the light from them. As a matter of fact, in new incandescent mantles a difference in colour was noticeable for a short time, but it disappeared after a short burning. No difference at all was indicated by spectroscopic examination of these mantles. In reply to Mr. Waite on the question of hemispherical candle-power, he said that Table 1 in the Paper was merely provided to indicate in some way the development of gas lighting over a period of years. He felt that Dr. Thomas had effectively answered Mr. Waite with regard to lumens and candle power. He reminded Mr. Waite that it was the surface of the road which was being lighted and not the centre, and what they were concerned with was the amount of useful light that fell on the surface of the road. A short time ago the Astronomer-Royal complained that the rays from vapour lamps in the Lewisham Road interfered with the work of the Greenwich Observatory because of the amount of light emitted in the upper hemisphere. Light which went up to the heavens was no good for lighting a road. Councillor Benwell was right when he said he did not want to know anything about lumens or candle power but that he did want to know the cost. Finally, Mr. Dean Chandler said he definitely challenged Mr. Jones' figures. Just before he came away for the Conference he had had a Supervia lamp tested and the luminous output was 370 lumens per cu.ft. for the lamp and refractor, and 380 excluding the refractor. Therefore, he could not understand how the National Physical Laboratory obtained the figures which Mr. Jones had mentioned, and he hoped Mr. Jones would accept Mr. Sawyer's invitation to clarify the whole matter.

All the Cardinal Points



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METERS

are specially designed for their work and register accurately, with a minimum of pressure loss under

The most severe tests

MANY SPECIAL AND DISTINCTIVE FEATURES ARE INCORPORATED AND ARE WELL WORTH YOUR EXAMINATION.

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George III
George IV
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Victoria
Edward VII
George V
Edward VIII
George VI

In this, the Coronation Year of our Gracious King, George VI, we celebrate our 144th birthday, and are proud to record that, as leading manufacturers of gas works plant, we have been closely associated with the Gas Industry through eight reigns.

Newton Chambers & Co Ltd
Thorncliffe Ironworks Nr Sheffield
1793 1937

Gas Markets and Manufactures

Stock Market Report

(For Stock and Share Lists, see later pages)

In addition to the Far Eastern crisis and the Mediterranean problem, markets had to contend last week with a break on Wall Street, and business remained quiet throughout the greater part of the period. At one time, however, there were signs of increased activity with a brighter tone, but this was short-lived and conditions quickly became dull again. British Funds, fortunately, maintained a firm front and any small improvements were held. Despite further good traffic returns, home rails were without support and at one time reached their lowest levels since May last, though there have been some slight recoveries since. In the industrial market, apart from a brisk demand for a few specialities, business was quiet, and many of the leaders lost ground. Mining shares were weak. Oils showed some improvement, and rubber shares were inclined to harden on an increase in the price of the commodity.

In common with other sections, business in the Gas Market again continued quiet. Prices, however, have not been adversely affected, and, with one exception, remained unchanged. In several instances the prices of transactions were a point or two above the previous week's best, but this was not sufficient to justify any change in the quotation. It will be seen in the Stock and Share Lists that a further batch of *ex* div. markings were recorded. The one change otherwise was a rise of 6 points in Lea Bridge ordinary to 164-169, at which price the yield on a dividend of 8½% works out at £5 2s.%, which is a high one for the security offered, but the stock is closely held and rarely available, thus tending to keep the quotation below its true level. The last recorded transaction in this stock was in April last at 160½.

The Directors of the Severn Valley Gas Corporation have announced an interim dividend on the ordinary shares of 2¾%, in respect of the year ending March 31 next. This compares with 2½% a year ago, the final distribution for 1936-37 being 2¾%. These shares are now obtainable at round about 22s. 7d., and assuming a final payment for the current year at the same rate as a year ago the return is £4 17s. 5d.%.

Current Sales of Gas Products

The London Market for Tar Products.

LONDON, *Sept.* 13.

The London tar products market remains steady at the following levels:

Pitch, 38s. per ton f.o.b.
Creosote, 6d. to 6¼d.
Refined tar, 3¾d.
Pure toluole, 2s. 5d. to 2s. 6d.; pure benzole, 1s. 9d.; 95/160 solvent naphtha, 1s. 8d.; and 90/160 pyridine, about 10s.; all per gallon at makers' works.

Tar Products in the Provinces.

Sept. 13.

The average prices of gas-works products during the week were: Gas-works tar, 23s. 6d. to 28s. 6d. Pitch—East Coast, 36s. to 37s. 6d. f.o.b. West Coast—Manchester, Liverpool, Clyde, 36s. to 37s. 6d.* Toluole, naked, North, 1s. 9d. to 1s. 10d. Coal tar, crude naphtha, in bulk, North, 8½d. to 9d. Solvent naphtha, naked, North, 1s. 5½d. to 1s. 6d. Heavy naphtha, North, 1s. 3d. to 1s. 3½d. Creosote, *ex* works, in bulk, North, liquid and salty, 5d. to 5½d.; low gravity, 4⅜d. to 4½d. Heavy oils, in bulk, North, 5d. to 5¼d. Carbolic acid 60's, 4s. 1½d. to 4s. 3d. Naphthalene, £18 to £20. Salts, 90s. to 95s., bags included. Anthracene "A" quality, 4½d. to 4¾d. per minimum 40% purely nominal; "B" quality, unsalable.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls whatever they may be

Tar Products in Scotland.

GLASGOW, *Sept.* 11.

New business is still rather scarce, but prices continue remarkably steady.

Crude gas-works tar.—Actual value is 37s. to 38s. per ton *ex* works in bulk.

Pitch.—Demand is slow, but makers' prices are maintained at round 30s. to 32s. 6d. per ton f.o.b. Glasgow for export, and 30s. per ton *ex* works in bulk for home trade.

Refined tar.—Only small parcels are changing hands for export, with prices unchanged at 3d. to 3¼d. per gallon free on rails for export, and 3½d. to 3¾d. per gallon *ex* works in buyers' packages for home trade.

Creosote oil.—Supplies are well looked after for prompt and forward delivery. The following prices can be taken as average obtained during the week: Specification oil, 5½d. to 5¾d. per gallon; low gravity, 6¼d. to 6½d. per gallon; neutral oil, 5¼d. to 5½d. per gallon; all *ex* works in bulk.

Cresylic acid.—Despite the lack of demand at the moment, quotations are well held as follows: Pale, 97/99%, 4s. 1d. to 4s. 4d. per gallon; dark, 97/99%, 3s. 10d. to 4s. per gallon; and pale, 99/100%, 4s. 6d. to 4s. 9d. per gallon; all *ex* works in buyers' packages.

Crude naphtha.—There is a fair outlet for this at round 6d. to 6¼d. per gallon *ex* works in bulk, according to quality and district.

Solvent naphtha.—90/160 grade is 1s. 5d. to 1s. 6d. per gallon, and 90/190 heavy naphtha, 1s. to 1s. 1d. per gallon.

Motor benzole can be secured at about 1s. 4½d. to 1s. 5d. per gallon.

Pyridine.—Prices are nominal at 8s. to 9s. per gallon for 90/160 grade, and 9s. to 10s. per gallon for 90/140 grade.

Benzole Prices.

These are considered to be the market prices for benzole at the present time:

	s. d.		s. d.	
Crude benzole . . .	0 9½	to	0 10	per gallon at works
Motor ,, . . .	1 3	,,	1 3½	,, ,, ,,
90% ,, . . .	1 4	,,	1 4½	,, ,, ,,
Pure ,, . . .	1 8	,,	1 8½	,, ,, ,,

Contracts Advertised To-Day

Coal.

Haworth Gas Department. [p. 702.]

Overseas Opportunities

Straits Settlements.

H.M. Trade Commissioner at Singapore reports that the Municipality of Singapore is calling for tenders (Contract No. 9) for the supply, delivery and erection of four gasholders, two of 50 ft. diameter and two of 70 ft. diameter, to be erected in sludge digestion tanks. Each gasholder should have a side depth of 10 ft. and should be provided with four manhole covers.

Tenders, endorsed "Tender for the supply of Gasholders for the Sewage Disposal Works," should be addressed either to the Municipal Secretary, Municipal Office, Singapore, or to the Inspecting Engineers, Messrs. Peirce & Williams, 1, Victoria Street, London, S.W. 1, by whom they will be received up to 4 p.m. and 10 a.m. respectively on Oct. 15, 1937. (Ref. T. 19170/37.)

Further Gas Undertakings' Results

Kilmarnock.

At a meeting of Kilmarnock Town Council last week it was reported that the revenue from gas consumed shows an increase of £2,026 and residuals have realized £1,939 more. For the year the surplus on the net revenue account was £414.

Oswaldtwistle.

The report of Mr. D. J. Colvin, Engineer and Manager of the Oswaldtwistle Gas Department for year ended March 31, 1937, states that the total quantity of gas sent out amounted to 108,303,000 cu.ft., a decrease of 4,624,000 cu.ft. over the previous year. Gas sold decreased by 3,507,540 cu.ft., or 3·24%. The net income from residuals, after deducting cost of handling, carting, &c., was £5,462, as against £5,254 last year, an increase of £208. The revenue expenditure and income during the year was £18,415 and £21,808, respectively, leaving a gross profit of £3,393, equal to 13·5% of the outstanding debt, as compared with a gross profit of £3,717 last year. Interest on loans, sinking fund instalments, and income-tax absorb £3,417, leaving a net profit of £362, as compared with £536 last year. Out of the net profit of £362 there is allocated the sum of £25 for new meters, and £337 to revenue surplus account. The value of the appliances sold through the showroom during the year amounted to £3,013 compared with £4,220 last year.

NEW VERTICAL RETORT PLANTS NOW IN REGULAR SERVICE

This installation, built for the Municipality of Svendborg, Denmark, is an interesting example of the modern Glover-West vertical retort plant designed for the smaller works. It is an eight-retort unit with fuel-gas producers equipped for breeze-burning, waste-heat recovery plant and electric lift. Coaling is by means of an automatic skip-hoist.

400 plants in 24 countries

WEST'S GAS IMPROVEMENT CO., LTD.

MANCHESTER: ALBION IRONWORKS, MILES PLATTING ■ **LONDON:** COLUMBIA HOUSE, ALDWYCH, W.C. 2

STOCK AND SHARE LIST

Official Quotations on the London Stock Exchange

Issue. £	Stock or Share	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Sept. 10	Rise or Fall on Week.	Transactions, Lowest and Highest Prices During the Week.
1,767,439	Stk.	Sept. 6	8	8	Alliance & Dublin Ord. ...	168—173*	−2	...
374,000	,,	June 21	4	4	Do. 4 p.c. Deb. ...	95—100	...	...
558,890	,,	Aug. 9	7	7	Barnet Ord. 7 p.c.	158—163	...	162½—162½
300,000	1	Apl. 5	1/4½	1/9½	Bombay, Ltd.	26/6—28/6	...	...
179,915	Stk.	Aug. 9	9½	9½	Bournemouth sliding scale ...	200—205	...	...
590,407	,,	,,	7	7	Do. 7 p.c. max. ...	158—163	...	160
493,960	,,	,,	6	6	Do. 6 p.c. Pref. ...	130—135	...	133¾—135
50,000	,,	June 21	3	3	Do. 3 p.c. Deb. ...	79—84	...	...
262,025	,,	,,	4	4	Do. 4 p.c. Deb. ...	98—103	...	99—100¾
335,000	,,	,,	5	5	Do. 5 p.c. Deb. ...	116—121	...	...
357,900	,,	Aug. 9	7½	7½	Brighton, &c., 6 p.c. Con. ...	152—157	...	...
649,955	,,	,,	6¼	6¼	Do. 5 p.c. Con. ...	135—140	...	137—140
205,500	,,	,,	6	6	Do. 6 p.c. 'B' Pref.	127—133	...	...
855,000	,,	Mar. 1	7	8	British Ord.	148—153	...	152
100,000	,,	June 21	7	7	Do. 7 p.c. Pref.	140—145	...	...
350,000	,,	,,	5½	5½	Do. 5½ p.c. 'B' Cum. Pref.	108—113	...	...
120,000	,,	June 7	4	4	Do. 4 p.c. Red. Deb. ...	95—100	...	...
450,000	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	102—107	...	...
450,000	,,	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	95—100	...	...
100,000	10	22 May '33	6	4	Cape Town, Ltd.	1⅞—2⅛	...	42 6—43/1½
100,000	10	6 Nov.'33	4½	4½	Do. 4½ p.c. Pref. ...	1⅞—3⅛	...	40/—42/6
150,000	Stk.	June 21	4½	4½	Do. 4½ p.c. Deb. ...	79—84	...	80½
626,860	,,	July 19	6	6	Cardiff Con. Ord.	125—130	...	...
237,860	,,	June 7	5	5	Do. 5 p.c. Red. Deb.	107—112	...	...
98,936	1	Apl. 5	2/-	2/-	Colombo Ord.	1⅝—1¾	...	...
24,510	1	,,	1/4½	1/4½	Do. 7 p.c. Pref. ...	23/—25/-	...	...
739,453	1	Mar. 15	-/11·48	-/11·48	Colonial Gas Assn. Ltd. Ord.	18/—20/-	...	...
296,144	1	,,	1/3·30	1/3·30	Do. 8 p.c. Pref.	22/6—24/6	...	...
1,775,005	Stk.	Aug. 9	5	5	Commercial Ord.	90—95	...	90—90¾
620,000	,,	June 7	3	3	Do. 3 p.c. Deb. ...	74—79	...	...
286,344	,,	Aug. 23	5	5	Do. 5 p.c. Deb. ...	113—118	...	...
807,560	,,	Aug. 9	7	7	Croydon sliding scale ...	140—145	...	143—144½
644,590	,,	,,	5	5	Do. max. div.	108—113	...	113
620,385	,,	June 21	5	5	Do. 5 p.c. Deb.... ...	113—118	...	...
239,000	,,	Aug. 9	5	5	East Hull Ord. 5 p.c....	98—103	...	...
185,355	,,	Aug. 9	6	6	East Surrey Ord. 5 p.c. ...	120—125	...	...
176,211	,,	June 7	5	5	Do. 5 p.c. Deb. ...	113—118	...	...
250,000	1	July 5	4	7	Gas Consolidation Ord. ...	20/—22/-	...	...
250,000	1	May 24	4	4	Do. 4 p.c. Red Cum. Pref.	19/—21/-	...	...
19,255,284	Stk.	Aug. 9	5½	5½	Gas Light & Coke 4 p.c. Ord.	24/3—25/3a	...	24/4½—25/-
2,600,000	,,	,,	3½	3½	Do. 3½ p.c. max.... ...	82—85	...	83½—84¾
4,477,106	,,	,,	4	4	Do. 4 p.c. Con. Pref. ...	99—102	...	100—101
2,993,000	,,	July 5	...	3½	Do. 3½ p.c. Red. Pref.	100—103	...	101—102½
8,602,497	,,	May 24	3	3	Do. 3 p.c. Con. Deb....	76—79	...	76½—78
3,642,770	,,	,,	5	5	Do. 5 p.c. Red. Deb....	111—114	...	111—113
3,500,000	,,	,,	4½	4½	Do. 4½ p.c. Red. Deb....	110—113	...	...
700,000	,,	Sept. 6	3½	3½	Do. 3½ p.c. Red. Deb....	94—99*	−1	96½—97½
270,466	,,	Aug. 23	6	6	Harrogate New Cons. ...	120—125	...	...
213,200	,,	Aug. 9	6	6	Hornsey Con. 3½ p.c. ...	118—123	...	...
5,600,000	,,	May 24	8	12	Imperial Continental Cap. ...	143—148	...	143½—146½
223,130	,,	July 19	3½	3½	Do. 3½ p.c. Red. Deb. ...	89—94	...	...
285,242	,,	Aug. 9	8½	8½	Lea Bridge 5 p.c. Ord. ...	164—169	+6	...
75,000	,,	May 24	†10	†10	Malta & Mediterranean ...	150—160	...	...
392,000	—	Apl. 1	5½	5½	Metropolitan (of Melbourne) 5½ p.c. Red. Deb.	98—103	...	...
231,978	Stk.	Aug. 23	5	5	M.S. Utility 'C' Cons. ...	101—106	...	...
968,657	,,	,,	4	4	Do. 4 p.c. Cons. Pref.	96—101	...	95—96½
360,075	,,	June 21	4	4	Do. 4 p.c. Deb. ...	97—102	...	...
148,955	,,	,,	5		Do. 5 p.c. Deb. ...	115—120	...	...
125,000	—	July 1	3½	3½	Do. 3½ p.c. Rd.Rg.Bds.	96—99	...	...
675,000	Stk.	May 3	†6	†9	Montevideo, Ltd.	89—94	...	91
250,000	,,	Aug. 9	7½	7½	North Middlesex 6 p.c. Con.	150—160	...	...
396,160	,,	Aug. 9	5	5	Northampton 5 p.c. max. ...	110—115	...	...
300,000	,,	Apl. 19	†9	†7	Oriental, Ltd....	162—167	...	...
468,537	,,	June 7	8	8	Plymouth & Stonehouse 5 p.c.	160—170	...	...
621,667	,,	Aug. 9	8¼	8¼	Portsmouth & Gosport Cons.	164—169	...	...
241,446	,,	,,	5	5	Do. 5 p.c. max. ...	104—109	...	...
73,350	,,	,,	5	5	Do. 5 p.c. Pref. ...	110—115	...	...
441,275	1	May 3	1/-	1/1½	Severn Val. Gas Cor. Ld. Ord.	21/—23/-	...	21/9—22/7½
460,810	1	Mar. 15	-/10½	-/10½	,, ,, 4½ p.c. Cum. Pref.	20/—22/-	...	20/4½—20/6
133,201	Stk.	Aug. 23	5	8½	Shrewsbury 5 p.c. Ord. ...	130—135	...	...
1,371,752	1	Sept. 6	1/2½	1/2½	South East'n Gas. Cn.Ld. Ord.	23/6—25/6*	−/6	24/-
871,636	1	,,	-/10½	-/1½	Do. 4½ p.c. Red. Cum. Pref.	20/—22/-*	...	...
498,818	1	,,	4	4	Do. 4 p.c. Cum. Pref. ...	18/—20/-*	−/6	...
450,000	Stk.	Aug 9	4	4	Do. 4 p.c. Deb.	99—102	...	...
150,000	,,	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	96—99	−1½	...
6,709,895	,,	Aug. 9	6	5	South Met. Ord.	103—106	−1	104—104¾
1,135,812	,,	,,	6	6	Do. 6 p.c. Irred. Pf. ...	130—135	...	...
850,000	,,	,,	4	4	Do. 4 p.c. Irred. Pf. ...	98—101	...	99—99½
1,895,445	,,	June 21	3	3	Do. 3 p.c. Deb. ...	75—80	...	76½—78½
1,000,000	,,	July 5	5	5	Do. 5 p.c. Red. Deb....	110—113	...	...
1,543,795	,,	Aug. 9	6	6	South Suburban Ord. 5 p.c....	120—125	...	...
512,825	,,	,,	5	5	Do. 5 p.c. Pref....	110—115	...	...
500,000	,,	,,	4	4	Do. 4 p.c. Pref....	95—100	...	...
250,000	,,	,,	...	§18/9	Do. 3¾ p.c. Red. Pref.	98—101	...	100
888,587	,,	June 7	5	5	Do. 5 p.c. Deb....	115—120	...	...
250,000	,,	,,	4	4	Do. 4 p.c. Deb....	97—102	...	...
200,000	,,	,,	...	...	Do. 3½ p.c. Red. Deb.	95—100	...	...
427,859	1	May 3	9⅜	1/2⅜	S. Western Gas & Water Ord.	19/—21/-	...	...
160,523	1	Apl. 19	-/10⅜	-/10⅜	Do. 4½ p.c. Red. Cum. Pf.	20/—22/-	...	...
110,000	Stk.	June 21	4	4	Do. 4 p.c. Red. Deb. ...	97—102	...	...
750,541	,,	Aug. 9	5½	5	Southampton Ord. 5 p.c. ...	111—116	...	114¾—114½
148,836	,,	June 7	4	4	Do. 4 p.c. Deb.	97—102	...	98½
350,000	,,	Aug. 23	5½	5½	Swansea 5½ p.c. Red. Pref. ...	110—115*	...	114½
94,000	,,	June 7	3½	3½	Do. 3½ p.c. Red. Deb. ...	95—100	...	95
1,076,490	,,	Aug. 9	6½	6½	Tottenham and District Ord.	135—140	...	...
409,835	,,	,,	5½	5½	Do. 5½ p.c. Pref....	121—126	...	125
62,235	,,	,,	5	5	Do. 5 p.c. Pref. ...	110—115	...	...
371,850	,,	June 7	4	4	Do. 4 p.c. Deb. ...	97—102	...	...
750,000	1	Apl. 5	4	6	U. Kingdom Gas Cor. Ord.	20/—22/-	...	20/9¾—21/-
936,338	1	May 3	4½	4½	Do. 4½ p.c. 1st Cum. Pref.	20/—22/-	...	20/9—21/3
740,933	1	June 7	4½	4½	Do. 4½ p.c.2nd Non-Cum.Pf.	17/—19/-	...	...
700,000	Stk.	Mar. 15	3½	3½	Do. 3½ p.c. Red. Deb. ...	96—99	...	...
373,939	,,	Aug. 9	7	7	Uxbridge, &c., 5 p.c. ...	147—152	...	...
133,010	,,	,,	5	5	Do. 5 p.c. Pref. ...	109—114	...	...
1,371,138	,,	Aug. 9	7	7	Wandsworth Consolidated ...	141—146	...	141
1,620,615	,,	,,	5	5	Do. 5 p.c. Pref. ...	117—122	...	...
500,000	,,	,,	4	4	Do. 4 p.c. Pref. ...	97—100	...	100
1,343,964	,,	June 7	5	5	Do. 5 p.c. Deb. ...	115—120	...	...
383,745	,,	,,	4	4	Do. 4 p.c. Deb. ...	97—102	...	...
558,342	,,	Aug. 9	7	7	Watford and St. Albans Ord.	140—145	...	...
200,000	,,	,,	5	5	Do. 5 p.c. Pref. ...	109—114	...	...
200,000	,,	,,	5½	5½	Do. 5½ p.c. Pref. ...	121—126	...	...
200,000	,,	June 7	4	4	Do. 4 p.c. Red. Deb.	97—102	...	...
100,000	,,	,,	3½	3½	Do. 3½ p.c. Red.Deb.	95—100	...	...

a.—The quotation is per £1 of Stock. * Ex div. † Paid free of income-tax. ‡ For year. ½ Actual.

Stock and Share List continued overleaf.

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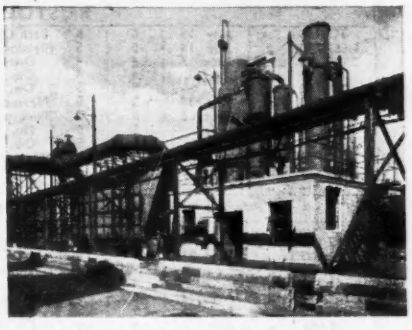

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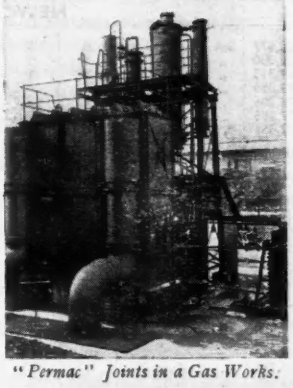

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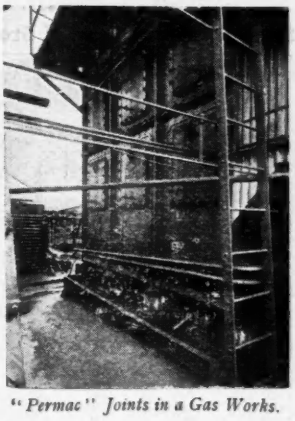

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Stocks Officially Quoted on Provincial Exchanges

Issue. £	Stock or Share	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations. Sept. 10.	Rise or Fall on Week.	Transactions, Lowest and Highest During the Week.
BRISTOL EXCHANGE.								
347,756	Stk.	July 19	6	5	Bath Cons.	119—121	...	...
1,667,250	,,	July 19	5	5	Bristol, 5 p.c. max.	117—118	...	...
120,420	,,	June 7	4	4	Do. 1st 4 p.c. Deb. ...	100½—102½	...	...
217,870	,,	,,	4	4	Do. 2nd 4 p.c. Deb. ...	100½—102½	...	...
328,790	,,	,,	5	5	Do. 5 p.c. Deb.	120—123	...	...
274,000	,,	July 19	5	5	Newport (Mon.) 5 p.c.max. ...	101—106	...	...
13,200	12	Sept. 6	8	7	Pontyp'l Gas & W. 10 p.c. 'A'	13—14*	−½	...
13,600	10	,,	6	5	Do. 7 p.c. 'B'	11⅞—12⅝*	−⅛	...
40,000	10	,,	6	5	Do. 7 p.c. 'C'	11⅞—12⅜*	−⅛	...
140,778	Stk.	Aug. 9	5	5	Weston-super-Mare Cons. ...	110—112	...	...
64,338	,,	June 21	4	4	Do. 4 p.c. Deb.	96—98	...	...
33,340	,,	,,	7½	7½	Do. 7½ p.c. Deb.	157—160	...	...
LIVERPOOL EXCHANGE.								
157,150	Stk.	Aug. 9	6½	5	Chester 5 p.c. Ord.	104—109	...	...
92,500	,,	June 21	4	4	Do. 4 p.c. Pref.	97—101	...	...
36,430	,,	,,	3½	3½	Do. 3½ p.c. Deb.... ...	89—92	...	...
41,890	,,	,,	4	4	Do. 4 p.c. Red. Deb. ...	98—102	...	...
2,167,410	,,	Aug. 23	6	6	Liverpool 5 p.c. Ord. ...	125—127	+½	...
245,500	,,	June 21	5	5	Do. 5 p.c. Red. Pref. ...	99—104	...	...
306,083	,,	July 1	4	4	Do. 4 p.c. Deb. ...	102—104	...	...
106,280	,,	Aug. 9	10	10	Preston 'A' 10 p.c.	206—216	...	...
188,219	,,	,,	7	7	Do. 'B' 7 p.c.	147—157	...	...
NEWCASTLE EXCHANGE.								
122,577	Stk.	Aug. 9	8	8	Blyth 5 p.c. Ord.	165—166	...	...
732,000	,,	Aug. 9	5	5	Hartlepool G. & W. Cn. & New	122—123	...	...
2,061,315	,,	Aug. 9	5⅔	5	Newcastle & Gateshead Con.	23/9—24/3*a*	−1/-	...
682,856	,,	,,	4	4	Do. 4 p.c. Pref. ...	97—99	...	...
776,706	,,	June 21	3½	3½	Do. 3½ p.c. Deb. ...	91—92	...	...
277,285	,	Nov. 2	5	5	Do. 5 p.c. Deb. '43...	108—109	...	...
332,351	,	Aug. 23	6	6	Sunderland 6 p.c. max. ...	139—141	...	...
NOTTINGHAM EXCHANGE.								
542,270	Stk.	Aug. 9	9	6	Derby Con.	150—160	....	...
55,000	,,	June 7	4	4	Do. 4 p.c. Deb.	100—105	...	...
84,750	,,	Feb. 17	5	12	Long Eaton 'A' Ord. ...	...	...	...
50,000	,,	,,	4	10	Do. 'B' Ord. ...	...	...	...
20,000	10	June 21	5	5	Do. 5 p.c. Pref. ...	10—12	...	...
80,000	Stk.	,,	5	5	Do. 5 p.c. Deb. ...	105—110	...	...
SHEFFIELD EXCHANGE.								
10,000	Stk.	Feb. 15	10	10	Great Grimsby 'A' Ord. ...	210—220	...	...
6,500	,,	,,	10	10	Do. 'B' Ord. ...	210—220	...	...
79,000	,,	,,	10	10	Do. 'C' Ord. ...	205—210	...	...
1,806,339	,,	Aug. 23	6	6½	Sheffield Cons.	145—149	...	...
95,000	,,	July 5	4	4	Do. 4 p.c. Deb.	100—103	...	...

Supplementary List of Stocks and Shares not Officially Quoted

202,152	Stk.	Sept. 6	25/-*b*	5	Ascot Ord.	100—105*	−2	...
128,182	,,	July 5	5	5	Do. 5 p.c. Pref.	108—113	...	...
573,156	1	May 24	5	5	Assd. Gas and Water Ord. ...	19/6—21/6	...	19/6
500,000	1	,,	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	19/6—21/6	...	20/6
500,000	Stk.	Sept. 6	3½	3½	Do. 3½ p.c. Red. Deb. ...	95—100*	...	...
31,035	1	Aug. 23	...	-/4½	Associated Utilities 4 p.c. Pref.	17/—19/-	...	16/6
100,000	Stk.	...	...	...	Do. 3½ p.c. Red. Deb.	95—100	...	...
17,000	,,	Aug. 23	8	8	Bognor Orig. Ord. 'A' ...	160—170	...	...
62,210	,,	,,	8	8	Do. New Addl. 'A' ...	160—170	...	...
87,160	,,	,,	7	7	Do. New 7 p.c. max. ...	141—146	...	...
37,440	,,	Aug. 9	10	10	Cam. Univ. & Town 10 p.c.max.	193—203	...	...
125,970	,,	,,	7	7	Do. 7 p.c. max.	135—140	...	...
39,025	,,	,,	5	5	Do. 5 p.c. max.	98—103	...	...
65,000	,,	Aug. 9	8½	7½	Eastbourne 'A' 5 p.c. ...	158—163	...	161—161½
198,000	,,	,,	7	6	Do. 'B' 3½ p.c.	128—133	...	130—130½
112,312	,,	,,	5	5	Do. 5 p.c. Pref.	108—113	...	...
130,000	,,	June 21	5	5	Do. 5 p.c. Deb.	115—120	...	...
24,000	30	Aug. 23	8½	8½	Great Yarmouth 8½ p.c. max.	44—49	...	...
59,400	30	,,	7½	7½	Do. 7½ p.c. max.	44—49	...	...
51,160	Stk.	June 7	5½	5½	Do. 5½ p.c. Deb.	120—125	...	...
152,600	,,	Sept. 6	9	8	Guildford Cons.	170—175*	−2	...
54,055	,,	,,	5	5	Do. 5 p.c. Pref.	110—115*	−2	...
68,250	,,	June 7	5	5	Do. 5 p.c. Deb.	113—118	...	114
156,600	,,	Aug. 23	7½	7½	Hampton Court Cons. ...	158—163	...	...
73,620	,,	Sept. 6	8½	8½	Luton Cons. 'A'	163—168*	−3	...
107,960	10	Mar. 15	4	5½	Mid Kent Ord.	9—10	...	...
230,940	Stk.	Aug. 9	10	10	Oxford & District Ord. ...	203—208	...	...
47,112	,,	,,	5	5	Do. 5 p.c. Pref.	108—113	...	...
50,000	,,	,,	6	6	Do. 6 p.c. Red. Pref. ...	110—115	...	...
126,193	,,	May 3	7½	7½	Peterborough Ord.	159—169	...	...
64,990	,,	Sept. 6	7½	6½	Redditch Ord.	125—135*	−2	...
166,850	,,	Aug. 9	8	8	Romford Ord.	155—165	...	...
60,000	,,	,,	4	4	Do. 4 p.c. Pref.	97—100	...	...
44,000	,,	Mar. 15	5	5	Do. 5 p.c. Deb.	115—120	...	...
25,570	,,	Aug. 9	5½	5½	Rugby 5½ p.c. Pref.	125—130	...	...
25,000	,,	,,	6	6	Do. 6 p.c. Red. Pref. ...	106—111	...	...
42,750	,,	June 7	5½	5½	Do. 5½ p.c. Deb.	122—127	...	...
10,950	,,	Aug. 23	8	8	Ryde Ord.	158—163	...	...
136,191	,,	Aug. 9	7	5	Scarborough Ord.	115—125	...	...
27,825	,,	Aug. 23	8	8	Shanklin & Ventnor Cons. ...	158—168	...	...
270,086	,,	Sept. 6	7	7	Slough Ord.	135—140*	−2	136
21,000	,,	June 21	5	5	Do. 5 p.c. Deb.... ...	112—117	...	...
28,872	1	May 24	5½	5½	S. Midland Gas Cpn. Ltd. Ord.	19/—21/-	...	...
28,866	1	Sept. 6	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	18/6—20/6*	...	...
137,730	Stk.	Aug. 9	7	7	Southgate & Dist. 7 p.c. max.	140—145	...	...
62,500	,,	,,	5	5	Do. 5 p.c. Pref.	110—115	...	...
117,228	,,	Aug. 23	5	5	Swindon Cons.	106—111	...	...
60,425	,,	June 7	5	5	Do. 5 p.c. Deb.	110—115	...	...
64,380	,,	June 7	5	5	Torquay and Paignton 5 p.c. Pf	110—115	...	...
130,000	,,	Aug. 9	8	5	Wakefield Ord.	120—125	...	...
81,650	,,	,,	5	5	Do. 5 p.c. max.	103—108	...	...
82,000	,,	Aug. 9	6	6	Weymouth Ord.	103—108	...	...
98,384	,,	Aug. 9	6	6	Wolverhampton 6 p.c. Pref....	125—130	...	...
160,000	,,	June 21	5½	5½	Do. 5½ p.c. Rd. Db	108—113	...	...
370,000	,,	Aug. 9	6	4	York Cons.	102—107	...	...
90,000	,,	June 21	5	5	Do. 5 p.c. Red. Deb. ...	105—110	...	...
133,640	,,	July 19	6½	6½	Yorktown (Cam.) 5 p.c Cons.	128—133	...	...
120,000	,,	,,	5	5	Do. 5 p.c. Pref.	108—113	...	...
35,000	,,	June 7	5½	5½	Do. 5½ p.c. Deb.	123—128	...	...

a The quotation is per £1 of Stock. *b* Actual for Quarter. * Ex div.

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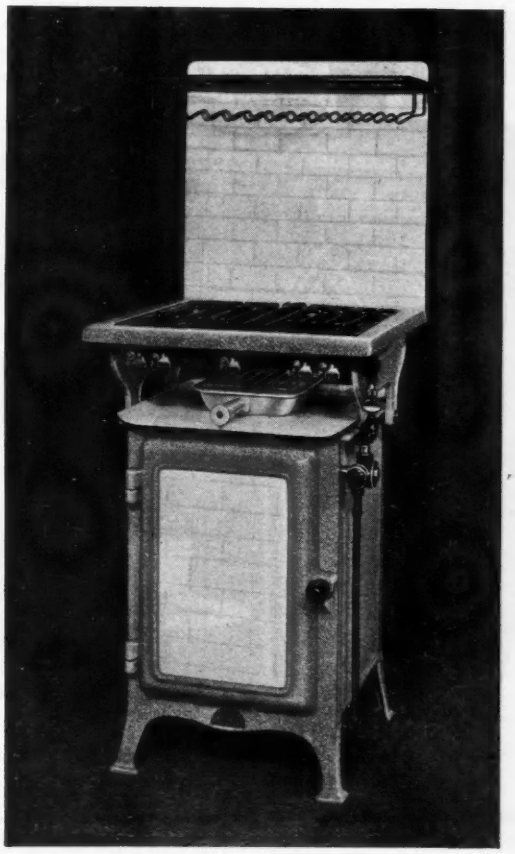

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